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Effect of some Micro-nutrients, Silicon and GA_3 Spraying on Yield and Fruit Quality of Pomegranate

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Abstract

Little is known about the response of pomegranate to the foliar application with nutrients and gibberellic acid. A randomized complete block design (RCBD) experiment was conducted on 40-years old Manfalouty pomegranate trees grown on Upper Egypt. The study aims to investigate the effect of foliar application with gibberellic acid (GA_3), potassium silicate (PS), zinc sulphate (ZS) and fetrilon compi (FC) which is a mixture of micronutrients on fruiting of pomegranate trees. All the tested treatments significantly ($P< 0.05$) improved the yield and fruit quality and reduced the fruit cracking percentage. GA_3 and FC spraying induced a 15 and 11% increase in the fruit yield and minimized the cracking percentage by 47 and 61% compared to the control treatment, respectively. It is recommended to spray Manfalouty pomegranate trees with micronutrients, potassium silicate, or zinc sulphate twice at mid of June and August to enhance the pomegranate yield and quality.

Keywords: *Pomegranate, GA_3, Silicon, Nutrients, Yield, Fruit quality.*

1. Introduction

Fruit trees are agricultural commodities of great biological and economical importance, and therefore, precise knowledge of treatments that boost fruit production, is of great importance. Pomegranate (*Punica-granatum* L.) is one of important fruits grown in tropical and sub-tropical regions (Khorsandi *et al*., 2009; Sheikh and Manjula, 2012). The fruit is a native of Iran and is extensively cultivated in Mediterranean regions since ages, especially in Spain, Morocco, Egypt and Afghanistan (Sheikh and Manjula, 2012). The pomegranate fruits had a high nutritional value, rich with sugars, vitamins, polyphenols and minerals Manfalouty pomegranate cultivar is one of the most important cultivars grown successfully in Upper Egypt (El-Salhy, 1996; Hasaballa, 2002; Khorsandi *et al*., 2009).

It is generally accepted that the appropriate nutrient management is crucial for optimizing plant crop production and to obtain a high fruit quality without environmental pollution (Vance, 2001). However, fruit growers usually apply larger amounts of chemical fertilizers to the soil than the tree actually needs, resulting to surface runoff and environmental pollution (Vance, 2001). Cracking is a serious problem in pomegranate and causes a major fruits loss, which is a serious commercial loss to farmers. Fruit cracking, seems to be a problem that lessens the marketability, sometimes the marketable yield reduction reach to 50% of the total yield (Melgarejo *et al*., 2004; Sheikh and Manjula, 2012; Torres-Olivar *et al*.,

2014). This problem is due to the improper water management, climate, tree nutrition and cultivars and lack of micronutrients (Singh *et al*., 2003; Kumar *et al*., 2010). The main cause for cracking is the combined action of high solar radiation, low humidity, high temperatures and low calcium concentrations (Sheikh and Manjula, 2012; Torres-Olivar *et al*., 2014).

Spraying with some growth regulators especially GA_3 reduced the fruit splitting (El-Khawaga 2003; Singl *et al*., 2003; El-Akkad *et al*., 2016; Merwad *et al*., 2016). The availability of most of micronutrients in soil especially Fe, Mn, Zn and Cu is low moreover, the translocation of these nutrients from soil to roots and from roots to shoots is low too (Eissa and Ahmed, 2016). Foliar sprays have been used as an important tool to meet tree nutrient demand and to overcome the soil application of micronutrients (Khorsandi *et al*., 2009). This fertilization method is more target-oriented and environmental friendly since the nutrients are applied in controlled quantities (Fernández and Eichert, 2009). Foliar application of macro and micronutrients were highly effective on improving nutritional status, yield and fruit quality of pomegranate trees (Khalil and Aly, 2013; Obaid and Al-Hadethi, 2013). Application of some micronutrients such as Fe, B, Mn and Zn increased fruit yield and reduced cracked fruit percentage (Ahmed *et al*., 2014; Merwad *et al.,* 2016). Application of silicon is beneficial on increasing the tolerance of plants to stresses as well as enhancing photosynthesis and leaf water potential. Spraying potassium silicate at 0.1% significantly increased yield and improved fruit quality of pomegranate trees (Epstein, 1999; Ahmed *et al*., 2015; Wassel *et al*., 2015).

This investigation aimed to study the effect of spraying with GA_3, potassium silicate, zinc sulphate and fetrilon compi on controlling cracking fruits damage and obtain high fruit quality of Manfalouty pomegranate trees.

2. Materials and Methods

The current study carried out during the seasons of 2016 and 2017 at the Pomology orchard of Faculty of Agriculture, Assiut University, Egypt. The soil of the studied site is classified as Typical Torrifluvents according to the Soil Survey Staff (2016) and has a silty loam texture (pH of 7.80, EC of 2 dS m^{-1} and $CaCO_4$ of 5%). Thirty trees of Manfalouty pomegranate which are forty years old and spaced at 5x5 m apart were chosen for this study. The trees were irrigated by flood surface irrigation system and received all the recommended horticultural practices. River Nile water (EC of 1.1 dS m^{-1}) was used in the irrigation of the experimental site. Each Manfalouty pomegranate tree was fertilized by the recommended dose of nitrogen, phosphorus and potassium.

The investigation included the following ten treatments:

1- Control (spraying water).
2- Spraying GA_3 at 25 ppm.
3- Spraying GA_3 at 50 ppm.
4- Spraying potassium silicate at 0.5%.
5- Spraying potassium silicate at 1%.
6- Spraying zinc sulphate at 500 ppm.
7- Spraying zinc sulphate at 1000 ppm.
8- Spraying fetrilon compi at 250 ppm.
9- Spraying fetrilon compi at 500 ppm.

10- Spraying fetrilon compi at 1000 ppm.

GA_3 as well as potassium silicate, zinc sulphate and fetrilon compi were sprayed twice at the mid of June and August in the two growth seasons. All nutrients were easily soluble in water. Fetrilon compi is a foliar fertilizer contains 4% Fe, 4% Zn, 3% Mn and 1.5% B in the chelating form (EDTA). Triton B as a wetting agent was added at a rate of 0.05% to all spraying solution before application.

The experiment was arranged in a randomized complete block design (RCBD) with ten treatments and three replications for each treatment, one tree per each.

During both seasons, the following parameters were measured: yield/tree (kg), fruit cracking (%), fruit weight (g), pulp (%) and juice volume (cm^3) as well as total soluble solids (TSS), total acidity, TSS/acid ratio and reducing sugars, according to A.O.A.C. (2000). Total anthocyanin content of juice was determined according to Rabino and Mancinelli (1986). Statistical analysis was done according to Snedecor and Cochran (1972). New L.S.D. at 5% level of the probability was used to compare the differences between the treatment means.

3. Results

3. 1. Yield and fruit cracking

Data presented in Table 1 show the effect of foliar application of GA_3, potassium silicate, zinc sulphate and fetrilon compi on the fruit yield and fruit cracking percentage of Manfalouty pomegranate trees during 2016 and 2017. It is obvious from the data that the results took the similar trend in the two studied seasons.

In general, all the studied treatments significantly increased the fruit yield compared to untreated ones. The maximum values of fruit yield (114 kg/tree) (two seasons average) were recorded on the trees that sprayed by GA_3 at 50 ppm. On other the hand, the minimum values (99.14 kg/tree) were recorded on untreated trees. All the studied treatments significantly increased the fruit yield compared to the control but little differences between the treatments were recorded. The fruit yield of Manfalouty pomegranate trees was found to decrease in the order: GA_3 50 > GA_3 25 > FC 500 >ZS 1000 > FC 1000 > PS 0.5 > PS 0.1 > ZS 500 > C. The foliar application of GA_3 caused an 15% increase in the fruit yield compared to the control. The application of $ZnSO_4$ or potassium silicate increased the fruit yield by 9-10% compared to the control, while the fetrilon compi at a rate of 500 ppm caused an 11% increase.

The studied treatments also reduced the cracking percentage. The highest significant values of cracking percentage (11.8%) were recorded in the unsprayed trees while the least values were recorded on the trees that sprayed by fetrilon compi at a rate of 500 ppm (4.57%). The fruit cracking percentage of Manfalouty pomegranate was found to decrease in the order: C > ZS 1000 > ZS 500 > GA_3 25 > GA_3 50 > PS 0.5 > PS 0.1 > FC 250 > FC 1000 > FC 500. The fruit cracking percentage was reduced from 11.8% in the control trees to 4.6% when the trees were sprayed by fetrilon compi at a rate of 500 ppm. The foliar application of micronutrients mixture in the form of fetrilon compi

was the most effective treatment on reducing the fruit cracking percentage.

The recorded fruit cracking percentage was 6.29, 6.07, 5.46, 5.39, 6.93, 7.27, 5.27, 4.57, 4.61 and 11.76% as an average of the two studied seasons due to the spray with GA_3 at 25, 50 ppm, potassium silicate at 0.5, 1%, zinc sulphate at 500, 1000 ppm, fetrilon compi at 250, 5000, 1000 ppm and unsprayed trees, respectively. Hence, the corresponding decrement percentage of fruit cracking percentage was attained to 46.51, 48.38, 53.57, 54.17, 41.07, 38.18, 55.19, 61.14 and 60.80% compared to control trees as an average of the two studied seasons, respectively for the treatments mentioned above.

Table 1. Effect of GA_3, silicon and mineral nutrients spraying on yield and fruit cracking of Manfalouty pomegranate during 2016 and 2017 seasons

Treatments	Yield (kg)/tree			Fruit Cracking (%)		
	2016	2017	Mean	2016	2017	Mean
Control	96.90	91.38	99.14	10.35	13.16	11.76
GA_3 25	118.70	109.21	113.96	6.67	5.90	6.29
GA_3 50	116.60	111.54	114.07	5.83	6.31	6.07
PS 0.5%	113.90	103.90	108.90	5.25	5.67	5.46
PS 1%	114.50	102.18	108.34	5.42	5.36	5.39
ZS 500	110.65	100.30	105.48	6.78	7.08	6.93
ZS 1000	114.80	104.46	109.63	7.10	7.44	7.27
FC 250	113.00	102.85	107.93	4.90	5.64	5.27
FC 500	115.70	104.30	110.00	4.45	4.58	4.57
FC 1000	114.90	103.86	109.38	4.76	4.36	4.61
$LSD_{0.05}$	5.82	6.31		0.93	1.39	

C= control.
GA_3 25 and GA_3 50= spraying with gibberellic acid at a rate of 25 and 50 ppm.
PS 0.5% and PS 0.1% = spraying with potassium silicate at a rate of 0.5 and 1%.
ZS 500 and ZS 1000 = spraying with zinc sulphate at a rate of 500 and 1000 ppm.
FC 250, FC 500 and FC 1000 = spraying with fetrilon compi at a rate of 250, 500 and 1000 ppm

3. 2. Fruit properties

3. 2.1. Physical characteristics

Data presented in Table 2 show the effect of foliar application of GA_3, potassium silicate, zinc sulphate and fetrilon compi on fruit weight, pulp and juice percentages of Manfalouty pomegranate fruits during 2016 and 2017. The results took similar trend during the two studied seasons. Generally, the results declared that all treatments significantly increased all the studied physical fruit properties compared with control (untreated ones).

The recoded fruit weight was 442.32, 431.25, 422.52, 424.66, 404.88, 410.59, 410.64, 414.06, 411.50 and 365.94 as an average of the two studied seasons due to spray with GA_3 at 25, 50 ppm, potassium silicate at 0.5, 1%, zinc sulphate at 500, 1000 ppm, fetrilon compi at 250, 500, 1000 ppm and unsprayed one, respectively. Hence, the corresponding increment percentages of fruit weight over unsprayed ones were 20.87, 17.85, 15.46, 16.05, 10.64, 12.20, 12.23, 12.88 and 12.45%, respectively. The highest values of these traits were recorded when the trees sprayed with GA_3, where, the fruit weight reached 442.32 and 431.25 g, pulp percentage reached

65.25 and 65.31% and juice percentage reached 43.32 and 42.85% as an average of the two studied seasons due to spray with GA_3 at 25 or 50 ppm, respectively. On the other hand, the least values were detected on fruit of untreated trees. These values attained 365.94 g, 58.16% and 39.25% as an average of the two studied seasons for fruit weight, pulp % and juice %, respectively. Hence, the increment percentages due to spray GA_3 at 25 or 50 ppm over unsprayed trees regarding fruit weight reached 20.87 and 17.85%, pulp percentage 12.19 and 12.29% and juice percentage 10.37 and 9.17% as an average of the two studied seasons, respectively.

Table 2. Effect of GA_3, silicon and mineral nutrients spraying on some physical fruit traits of Manfalouty pomegranate during 2016 and 2017 seasons

	Fruit weight (gm)			Pulp %			Juice %		
	2016	**2017**	**Mean**	**2016**	**2017**	**Mean**	**2016**	**2017**	**Mean**
Control	391.28	340.60	365.94	56.80	59.52	58.16	38.60	39.90	39.25
GA_3 25	471.39	413.25	442.32	64.21	66.28	65.25	42.41	44.22	43.32
GA_3 50	460.17	402.33	431.25	64.82	65.80	65.31	41.80	43.89	42.85
PS 0.5%	449.33	395.70	422.52	60.39	63.58	61.99	41.23	42.86	42.05
PS 1%	456.52	392.80	424.66	62.33	63.36	62.85	41.84	42.48	42.16
ZS 500	431.75	378.00	404.88	60.80	62.71	61.76	40.94	42.00	41.47
ZS 1000	439.67	381.50	410.59	60.93	63.38	62.16	41.58	42.81	42.19
FC 250	438.38	383.00	410.69	61.05	63.19	62.12	41.11	42.59	41.85
FC 500	440.00	386.11	413.06	61.88	64.22	63.05	41.88	43.28	42.58
FC 1000	442.16	381.00	411.50	62.47	64.85	63.66	41.12	43.65	42.39
$LSD_{0.05}$	20.55	18.42		2.36	2.18		1.98	2.11	

3.2.2. Chemical fruit constituents:

Data presented in Tables 3 and 4 showed that the foliar application of potassium silicate, zinc sulphate and fetrilon compi significantly improved the fruit chemical properties in terms of increasing the total soluble solids, reducing sugars, TSS/acid ratio, anthocyanin and vitamin C contents and reducing the total acidity percentage compared to GA_3 spraying or unsprayed ones. On the other hand, spraying of GA_3 either at 25 or 50 ppm significantly decreased the total soluble solids, reducing sugars, TSS/acid ratio and anthocyanin and significantly increased vitamin C content compared to unsprayed ones.

The recorded TSS values were 14.66, 15.12, 16.58, 16.85, 16.70, 16.54, 16.77, 16.97, 17.00 and 15.54 as an average of the two studied seasons due to spray with GA_3 at 25, 50 ppm, potassium silicate at 0.5, 1% zinc sulphate at 500, 1000 ppm and fetrilon compi at 250, 500 & 1000 ppm, respectively. The increment percentages of TSS attained 6.64, 8.43, 7.46, 6.44, 7.92, 9.20 and 9.40% due to spray potassium silicate or 0.5, 1% zinc sulphate at 500 or 1000 ppm and fetrilon compi at 250, 500 and 1000 compared to unsprayed ones, respectively.

The maximum values of TSS (16.97 and 17.00%), reducing sugar (12.09 and 12.20%) and anthocyanin content (64.08 and 64.07) as an average of the two studied seasons were recorded due to the spray by fetrilon compi at 500 or 1000 ppm, respectively. Whereas, the minimum values

of TSS (14.66 and 14.52%), reducing sugar (10.68 and 10.79%) and anthocyanin content (55.67 and 55.21%) as an average of the two studied seasons were detected due to GA_3 spraying at 25 and 50 ppm, respectively. These values were 15.54, 11.03 and 58.66% as an average of the two studied seasons due to unsprayed ones, respectively. Hence, the corresponding increment percentages of these traits due to fetrilon compi at 500 or 1000 ppm over unsprayed ones attained (9.20 and 9.40%) for TSS, (9.61 and 10.61%) for reducing sugars and (9.24 and 9.22%) for anthocyanin content as an average of the two studied seasons, respectively. As well as, the corresponding decrement percentages of TSS attained (5.66 and 6.56%), reducing sugar (3.17 and 2.18%) and anthocyanin content (5.10 and 5.88%) as an av. of the two studied seasons) due to spray GA_3 at 25 or 50 ppm compared to untreated ones.

Table 3. Effect of GA_3, silicon and mineral nutrients spraying on TSS, acidity and TSS/acid ratio of Manfalouty pomegranate during 2016 and 2017 seasons

Treatments	TSS %			Acidity %			TSS/acid ratio		
	2016	2017	Mean	2016	2017	Mean	2016	2017	Mean
Control	15.20	15.87	15.54	1.38	1.43	1.41	10.04	11.10	11.07
GA_3 25	14.38	14.94	14.66	1.40	1.48	1.44	10.23	10.38	10.33
GA_3 50	14.23	14.81	14.52	1.46	1.54	1.50	9.75	9.62	9.69
PS 0.5%	16.20	16.95	16.58	1.10	1.18	1.14	14.73	14.36	14.68
PS 1%	16.60	17.10	16.85	1.16	1.22	1.19	14.31	14.62	14.47
ZS 500	16.40	17.00	16.70	1.08	1.23	1.16	15.19	13.82	14.51
ZS 1000	16.20	16.88	16.54	1.12	1.23	1.18	14.46	13.72	14.73
FC 250	16.33	17.20	16.77	1.08	1.20	1.14	15.12	14.33	14.90
FC 500	16.60	17.33	16.97	1.06	1.18	1.12	15.66	14.69	15.18
FC 1000	16.70	17.30	17.00	1.10	1.15	1.13	15.18	15.09	15.14
$LSD_{0.05}$	0.58	0.53		0.06	0.05		0.63	0.76	

Table 4. Effect of GA_3, silicon and mineral nutrients spraying on reducing sugars, anthocyanin and V.C. of Manfalouty pomegranate during 2016 and 2017 seasons

Treatments	Reducing sugar (%)			Total Anthocyanin (mg/100g)			Vitamin C		
	2016	2017	Mean	2016	2017	Mean	2016	2017	Mean
C	10.84	11.21	11.03	59.11	58.20	58.66	22..30	22.93	23.12
GA_3 25	10.56	10.80	10.68	56.93	56.40	55.67	27.25	26.80	27.03
GA_3 50	10.87	10.92	10.79	57.67	56.75	55.21	26.98	25.95	26.47
PS 0.5%	11.51	12.11	11.81	62.87	61.54	62.21	29.80	29.70	29.75
PS 1%	11.67	11.80	11.74	63.58	63.40	63.49	28.48	29.67	29.08
ZS 500	11.65	11.99	11.82	62.95	61.62	62.29	29.20	30.90	30.05
ZS 1000	11.42	11.83	11.63	62.64	61.98	62.31	30.13	31.08	30.61
FC 250	11.67	12.28	11.98	63.11	61.74	62.43	29.41	31.25	30.33
FC 500	11.70	12.48	12.09	64.70	63.46	64.08	30.80	31.10	30.95
FC 1000	11.73	12.67	12.20	64.45	63.68	64.07	31.15	31.24	31.19
$LSD_{0.05}$	0.32	0.44		2.53	2.05		0.88	1.21	

4. Discussion

Spraying with some growth regulators especially GA_3 has a lot of benefits in horticulture crops e.g., improving the fruiting and yield quality. Gibberellins are involved in cell division and cell elongation resulted in increase the fruit weight and size.

It delayed the fruit maturation and senescence of fruit as well as reduced the fruit splitting (El-Salhy, 1996; Kuldeep *et al*., 2001; Singh *et al*., 2003). In the current study, the foliar application of GA_3 caused about 15% increase in the fruit yield of Manfalouty pomegranate and reduced the fruit cracking percentage by about 47% compared to the control. These results are in line with those obtained by El-Salhy, 1996, Mohamed (2004), Merwad *et al*. (2016), Digrase *et al*. (2016) and El-Akkad *et al*. (2016). They revealed that there is a potential benefit from GA_3 in the commercial production of pomegranate for its effective influence on yield and fruit quality.

Micronutrients, i.e. Fe, Mn, Zn and B play a great role in plant growth, yield and fruit quality as a result of affecting many physiological processes in plant life and activating a large numbers of enzymes. Mirzapour and Khoshgoftarmanesh, (2013). The data of the current study revealed that the application of a mixture of micronutrients caused a 10% increase in the fruit yield and reduced the cracking percentage by about 60% compared to the control These results agreed with those reported by Ahmed *et al*. (2014) and Merwad *et al*. (2016). The current study confirmed that the application of micronutrients increased the total soluble solids, reducing sugars, TSS/acid ratio, anthocyanin and vitamin C contents and reduced the total acidity percentage compared to unsprayed trees. The foliar application of micronutrients has a great ability to improve the quality of pomegranate fruit (Hassani *et al*. 2012, Obaid and Al-Hadethi, 2013).

Silicon has a beneficial effect on increasing the tolerance of plants to stresses as well as enhancing photosynthesis and leaf water potential (Ahmed *et al.,* 2015). Previous studies showed that the application of silicon was very effective in promoting growth and fruiting of fruit crops (Epstein, 1999; Ahmed *et al*., 2015). It is responsible for maintaining plant water balance as well as stimulates water transport and root growth (Levitt, 1980 and Epstein, 1999). The current study showed that the application of potassium silicate significantly increased the yield and quality of pomegranate fruit. The effect of silicon in improving yield and fruit quality of pomegranates was supported by Ahmed *et al*. (2014) and Wassel et al. (2015). The spraying of pomegranate tree by a 1% of potassium silicate caused about 60% increase in the fruit yield; moreover, this treatment improved the quality of fruit. Previous studies showed that silicon increased the activities of antioxidant enzymes in the leaves that protect plant tissues from oxidative damage under unfavorable conditions (Levitt, 1980 and Epstein, 1999).

5. Conclusion

The response of Manfalouty pomegranate trees to the foliar application of potassium silicate, micronutrients and gibberellic acid was investigated in a two -years field study. The application of fetrilon compi (4% Fe, 4% Zn, 3% Mn and 1.5% B) was more effective in reducing the cracking percentage, while the gibberellic acid was more effective in increasing the fruit yield. The foliar application

of potassium silicate and micronutrients gave the highest values of total soluble solids, reducing sugar, anthocyanin and vitamin C; moreover, these treatments significantly decreased the acidity compared to unsprayed trees. It can be concluded that the foliar application of pomegranate trees with fetrilon compi at 500 ppm, zinc sulphate at 500 ppm or potassium silicate at 0.5% twice at mid of June and August is recommended to get high yield with good fruit quality and reducing fruit cracking percentage.

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تأثير رش بعض العناصر والسيلكون وحمض الجبريليك علي إثمار أشجار الرمان المنفلوطي

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الملخص

أجريت هذه الدراسة بمزرعة الفاكهة – كلية الزراعة – جامعة أسيوط، مصر خلال موسمي النمو ٢٠١٦ و ٢٠١٧ بهدف دراسة تأثير رش حمض الجبريليك وسليكات البوتاسيوم وسلفات الزنك وفتريليون كومبي علي محصول وخصائص ثمار الرمان المنفلوطي.

حيث تم رش هذه المركبات بالتركيزات الآتية GA3 (٢٥ ، ٥٠ ppm)، سليكات البوتاسيوم (٠,٥ ، ١%) وسلفات الزنك (٥٠٠ ، ١٠٠٠ ppm) وفتريليون كومبي (٢٥٠ ، ٥٠٠ ، ١٠٠٠ ppm) مقارنة بالرش بالماء فقط.

وقد أوضحت النتائج ما يلي:

- أدي الرش بحمض الجبرييك وسليكات البوتاسيوم وسلفات الزنك وفتريليون كومبي إلي زيادة معنوية في وزن المحصول/شجرة مع نقص معنوي في نسبة تشقق الثمار مقارنة بمحصول الأشجار الغير مرشوشة (الكنترول).
- أدت جميع المعاملات إلي زيادة جوهرية في صفات الثمار الطبيعية من حيث زيادة وزن الثمرة ونسبة اللب وحجم العصير مقارنة بالكنترول.
- أدي الرش بـ فتريليون كومبي وسلفات الزنك وسليكات البوتاسيوم إلي تحسين المكونات الكيميائية للثمار من حيث ذيادة المواد الصلبة الذائبة الكلية والسكريات وصبغة الأنثوسيانين وفيتامين C بينما أدي الرش بحمض الجبريليك إلي نقص معنوي في المكونات الكيميائية للثمار مقارنة بالكنترول.

من نتائج هذه الدراسة نوصي بأهمية رش فتريليون كومبي بتركيز ٥٠٠ ppm وسلفات الزنك ٥٠٠ ppm وسليكات البوتاسيوم ٠,٥% مرتين في منتصف شهري يونيو وأغسطس لإنتاج محصول عال ذو ثمار جيدة مع تقليل نسبة تشقق ثمار الرمان صنف المنفلوطى تحت الظروف المشابهه لهذه الدراسة.