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ATTEMPTS TO FIND BEST PREHARVEST TREATMENT REQUIRED FOR OBTAINING OPTIMUM MARKETABLE FRUITS AND ITS EFFECT ON STORAGE LIFE OF 'MANFALOUTY' POMEGRANATES : I. EVALUATING OF SOME SOIL AND FOLIAR TREATMENTS ON SPLITTING, SUNBURN, YIELD AND FRUIT QUALITY

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ABSTRACT

Three soil treatments including mineral and bio-fertilizers as well as eleven foliar treatments of antioxidant, organic material, some macro and micro elements were examined on 'Manfalouty' pomegranate trees grown in sandy soil in a trial to solve the problem of sunburn damage and splitting and to improve yield and fruit quality.

Obtained results indicated that, foliar sprays of a mixture containing kaolin (2%), micronutrients (Chelated form of Fe, Zn and Mn each at 0.1% plus Boric acid at 0.05% & $CuSO_4$ at 0.05%) and macronutrients ($CaCl_2$ & $MgSO_4$ each at 1.0%) at the 1st week of May, June, July and August in addition to amending the soil with 500g mineral N, 150g P_2O_5 + 75g phosphorine and 360g K_2O /tree/year gave promising results. This treatment was found to be the best treatment required for producing maximum yield and optimum fruits that suitable for market and export standards.

INTRODUCTION

Pomegranate trees (*Punica granatum* L.) are widely grown in many tropical and subtropical countries, especially in the moderate climate of the Mediterranean region (Sheets, 2004). This tree species is well adapted to marginal lands and arid soils. In Egypt, pomegranate trees are mainly grown in Assiut governorate, where summer temperatures normally rise up to 40 °C or more.

Pomegranate fruits are characterized by their higher nutritional and medicinal values (Morton, 1987), but intense exposure of the fruit to sunlight can cause sunburn damage (large black spots on the fruit skin) and /or fruit cracking, which render the fruit unmarketable. Pomegranates are especially sensitive to sun because they are terminal-bearing plants (Melgarejo *et al.*, 2004). The incidence of sunburn damage and/ or fruit splitting cause high losses to the grower. In addition, most of pomegranate growers in Egypt believed that trees could be successfully grown under minimal agriculture management practices, which may be a reason for maximizing the problem of cracking. Tucker *et al.*, (1994) reported that potassium deficiency results in small, thin-skinned fruit and promotes fruit splitting; extra potassium will not always correct the normal splitting in susceptible cultivars. They also added that balanced cultural programs, particularly irrigation, could be effective to control this problem. They observed another type of splitting, characterized by irregular cracks frequently at right angles to the fruit axis which is a symptomatic of severe copper deficiency.

Singh *et al.*, (1993) reported that good cultural practices were effective in lowering fruit cracking percentage of 'Kandhari' and 'Beedana' pomegranate cvs. Similar observations were also reported by Rangari *et al.*, (2000) on 'Ganesh' pomegranate trees. Abdel-Aziz *et al.*, (2001) found that foliar sprays of a mixture containing calcium chloride (0.5%), potassium sulphate (0.5%) and boric acid (0.05%) were relatively effective in alleviating the number of cracked fruits and in improving both yield and quality of 'Manfalouty' pomegranate cv. Sunburn damage of fruits was reduced from 21.9% in untreated control to 9.4% in the kaolin-treated fruits (Melgarejo, 2004). On the other hand, El-Kassas (1983a and 1983b) mentioned that the number of cracked fruits of 'Manfalouty' pomegranates was increased as a result of mineral nitrogen and phosphorus fertilization. Therefore, this experiment was conducted to improve yield and fruit quality of 'Manfalouty' pomegranate trees and to control fruit's splitting and sunburn for improving their marketing values by testing some soil and foliar spray treatments.

MATERIAS AND METHODS

This research was carried out during 2006 and 2007 seasons on a private orchard of 'Manfalouty' pomegranate trees (7 year) located at East Beni-Mazar, about 65 km north of Minia city. A composite sample from the experimental soil was taken and analyzed one week prior to commencing the experiment according to Wilde *et al.*, (1985) and the obtained data are given in Table 1.

Table 1: Soil analysis of the experimental orchard

Items	Values	Items	Values
Sand (%)	94.0	N %	0.016
Silt (%)	2.5	P (meq/100g)	3.00
Clay (%)	3.5	K (meq/100g)	0.26
Texture	Sand	Ca (meq/100g)	0.30
pH (1 : 2.5)	9.08	Mg (meq/100g)	0.11
E.C. mmohs/cm	0.09	Fe (ppm)	2.20
Total Salts (E.C x 640)	57.6	Mn (ppm)	1.24
$CaCO_3$ %	9.15	Zn (ppm)	0.26
O.M. %	0.091	Cu (ppm)	0.25

Two hundred and ninety seven trees uniform in vigorous as possible were selected and subjected to the recommended horticultural practices. The selected trees were fertilized with farmyard manure during mid December at 4 farm baskets /tree. Orchard was managed carefully concerning weed, diseases and pest control throughout the whole season. The chosen trees were pruned at the first week of January and the trunk of each tree was painted with a saturated solution of sodium bicarbonate followed by lime solution, one month later. Thereafter, the trees were subjected to some soil and foliar applications. Foliar treatments included some macro and micro nutrients in addition to the use of some organic materials and antioxidant treatments. Thirty-three treatments (three soils and eleven foliar application treatments) were tested in this regard, and each treatment was replicated three times, three trees per each (Table2).

Table 2: Soil and foliar treatments used in the experiments on pomegranate trees

Soil application	Foliar Application	Spraying concentration
1- N : P : K	Water	
	1. ά- Tocopherol (vitamin E)	0.1% (A)
	2. Surround WP (Kaolin)	2.0% (B)
	3. $CaCl_2$ + $MgSO_4$ (Macro-N)	1.0% + 1.0% (C)
2- N : P+ : K	4. Chelated form of Fe, Zn and Mn + Boric acid & $CuSO_4$ (Micro-N)	0.1, 0.1 and 0.1% + 0.05% & 0.05%, respectively (D)
	1+3. Vitamin E + (Macro-N)	(A) + (C)
	1+4. Vitamin E + (Micro-N)	(A) + (D)
	2+3. Kaolin + (Macro-N)	(B) + (C)
3- N+ : P : K	2+4. Kaolin + (Micro-N)	(B) + (D)
	1+3+4. Vitamin E + (Macro-N) + (Micro-N)	(A) + (C) + (D)
	2+3+4. Kaolin + (Macro-N) + (Micro-N)	(B) + (C) + (D)

P+: Phosphorus was added in mineral plus bio-fertilizer sources
N+: Nitrogen was added in mineral plus bio-fertilizer sources
N : P : K: Minerals were added just in mineral source

Three soil application were applied in this experiment. The level and source of potassium (K) were the same in all treatments, while differed in both nitrogen (N) and phosphorus (P). Potassium at 360g K_2O /tree in the form of potassium sulphate (48.0% K_2O, 750g fertilizer /tree) was added into three equal batches during the first week of March, May and July. Nitrogen was also added into three equal batches, like those of potassium, in two forms:

1- 500g N in the form of ammonium nitrate fertilizer (33.5% N, 1500g fertilizer /tree) (N)

2- 340g N as ammonium nitrate fertilizer (1000g fertilizer /tree) plus 160g Minia Azoten (new bio-fertilizer) /tree (N+).
Minia Azoten was added twice at the last week of February and again at the last week of March.

Phosphorus was added into two forms:

1- 150g P_2O_5 as mono calcium superphosphate fertilizer form (15% P_2O_5, 1000g fertilizer /tree) plus 75g phosphorine (Bio-fertilizer) /tree (P+)
2- 225g P_2O_5 as calcium superphosphate fertilizer form (1500g fertilizer /tree) (P)

Calcium superphosphate fertilizer was added once in the middle of December, while phosphorine was added twice like those of Minia Azoten.

Therefore the three soil treatments were as follows:

1- 500g N (1.5kg ammonium nitrate /tree/year), 225g P_2O_5 (1.5kg calcium superphosphate /tree/year) and 360g K_2O (0.75kg potassium sulphate /tree/year) (N : P : K) (Positive control).
2- 500g N (1.5kg ammonium nitrate /tree/year), 150g P_2O_5 (1.0kg calcium superphosphate /tree/year) + 75g phosphorine and 360g K_2O (0.75kg potassium sulphate /tree/year) (N : P+ : K).
3- 340g N (1.0kg ammonium nitrate /tree/year) + 160g Minia Azoten, 225g P_2O_5 (1.5kg calcium superphosphate/tree/year) and 360g K_2O (0.75kg potassium sulphate/ tree/year) (N+ : P : K).

Eleven foliar treatments were applied four times per each at the 1st week of May, June, July and August. These treatments were: Tr.1-ά-Tocopherol (vitamin E) at 0.1% as an antioxidant, Tr.2-Kaolin at 2.0% as organic material, Tr.3-Calcium chloride and magnesium sulphate each at 1.0% as macronutrient materials, Tr.4-Chelated form of Fe, Zn and Mn each at 0.1% plus Boric acid at 0.05% & $CuSO_4$ at 0.05% as micronutrient materials, Tr.5-Antioxidant plus macronutrients (Tr.1 + Tr.3), Tr.6-Antioxidant plus micronutrients (Tr.1 + Tr.4), Tr.7-Organic treatment plus macronutrients (Tr.2 + Tr.3), Tr.8-Organic treatment plus micronutrients (Tr.2 + Tr.4), Tr.9-Antioxidant plus macro and micro nutrients (Tr.1 + Tr.3 + Tr.4), Tr.10-Organic treatment plus macro and micro nutrients (Tr.2 + Tr.3 + Tr.4) and Tr.11-Normal water (Control). Trees were sprayed till run-off with the tested materials using 0.1% triton-B as a surfactant. The same rate of triton-B was also added to the water of control treatment.

Trees were observed for yield and fruit's splitting and sunburn degrees. Cracked and sunburned fruit percentages were calculated relative to the total number of fruits per tree. About 6 kg of fruits per each managed and treated tree were randomly collected at time of harvest (1st week of September, in both seasons) and transferred to laboratory at the Faculty of Agriculture, Minia Univ. for the determination of the following physical and chemical attributes in relation to orchard treatments:

1- Average fruit weight (g).
2- Peel weight (g), arils weight (g) and edible /non-edible portion ratio.
3- Juice content of total soluble solids (%), titratable acidity (%) (as g citric acid /100 ml juice) and TSS /acid ratio.
4- Juice content of ascorbic acid (vitamin C) (mg /100g juice) (A.O.A.C., 1985).
5- Juice content of tannins (%) (Ranganna, 1978).
6- Arils content of N, P and K (%). These minerals were also calculated as grams in whole fruit arils /tree.

Experimental design and statistical analysis: Experiment was set in a completely randomized blocks design in a split plot arrangement with three replicates each consisted of three trees. The main plots were devoted to the three soil treatments (Factor A). The sub plots were devoted to the eleven foliar treatments (Factor B). Data were analyzed by ANOVA and the significance among treatment mean values were determined by least significant difference (LSD) at the $P<0.05$ level (Gomez and Gomez, 1984).

RESULTS AND DISCUSSIONS

Effect of soil treatments on fruit splitting and sunburn.

Results in Tables 3 and 4 show that partial replacement of either mineral N or mineral P fertilizers by biofertilizers resulted in more marketable fruits than in positive control trees (receiving the total amount of N and P in mineral source only). A significant reduction in the percentages of fruit's splitting and sunburn damage was achieved by bio-fertilization treatments. The use of Azotien was superior to phosphorine, in this respect.

Table 3: Effect of various foliar and soil treatments on fruit splitting percentage of "Manfalouty" pomegranates during 2006 and 2007 seasons.

Treatments	Splitting (%)							
	2006				2007			
	N:P:K	N:P+:K	N+:P:K	Mean (B)	N:P:K	N:P+:K	N+:P:K	Mean (B)
Control	12.3	9.6	8.2	10.0	14.2	9.0	8.3	10.5
T-pherol (V.E)	8.0	7.0	5.9	7.0	10.7	7.1	6.0	7.9
Kaolin	7.6	6.4	4.8	6.3	7.8	6.1	4.0	6.0
Micronutrients	11.0	7.8	6.8	8.5	13.8	8.8	7.5	10.0
Macronutrients	9.5	6.4	5.4	7.1	11.3	7.5	6.9	8.6
E + Micro	8.2	6.3	5.6	6.7	9.5	6.4	4.3	6.7
E + Macro	7.3	5.0	4.7	5.7	7.7	5.1	3.6	5.5
K + Micro	6.7	4.5	3.3	4.8	8.2	5.0	3.4	5.5
K + Macro	6.3	3.6	2.7	4.2	5.9	4.2	2.8	4.3
E + Mi + Ma	5.9	3.9	3.1	4.3	7.5	4.0	1.9	4.4
K + Mi + Ma	5.9	2.6	1.8	3.4	7.6	2.5	1.5	3.9
Mean (A)	8.1	5.7	4.7		9.5	6.0	4.6	
LSD at 5%	A: 0.2	B: 0.4	AB: 0.8		A: 0.4	B: 0.6	AB: 1.2	

1- N : P : K = 500g mineral N, 225g P_2O_5 and 360g K_2O /tree/year.

2- N : P+ : K = 500g mineral N, 150g P_2O_5 + 75g phosphorine and 360g K_2O /tree/year.

3- N+ : P : K = 340g mineral N + 160g Minia azoten, 225g P_2O_5 and 360g K_2O /tree/year.

The effect of bio-fertilization treatments in decreasing the level of sunburn damage and fruit splitting degree could be attributed to their direct effect in improving sandy soil properties and nutrient uptake by the trees. Surico *et al.*, (1984) stated that soil microorganisms might have more than one mode of action on plant nutrition. Singh *et al.*, (1993) reported that good cultural practices were effective in lowering fruit cracking percentage of 'Kandhari' and 'Beedana' pomegranate cvs. Similar results were also reported by Rangari *et al.*, (2000) on 'Ganesh' pomegranate trees.

Table 4: Effect of various foliar and soil treatments on fruit sunburn percentage of "Manfalouty" pomegranates during 2006 and 2007 seasons.

Treatments	Sunburn (%)							
	2006				2007			
	N:P:K	N:P+:K	N+: P:K	Mean (B)	N:P:K	N:P+:K	N+:P:K	Mean (B)
Control	19.4	15.4	11.6	15.5	22.2	16.6	12.1	17.0
T-pherol (V.E)	15.6	10.5	7.7	11.3	13.6	11.2	10.4	11.7
Kaolin	12.6	8.1	4.8	8.5	10.9	9.7	6.5	9.1
Micronutrients	17.4	11.9	9.4	12.9	18.8	16.1	11.0	15.3
Macronutrients	16.5	10.7	8.5	11.9	16.0	12.2	10.3	12.8
E + Micro	14.0	8.8	6.1	9.6	13.7	9.8	7.3	10.3
E + Macro	11.8	7.3	5.8	8.3	12.8	8.7	6.0	9.2
K + Micro	9.7	6.2	3.7	6.5	9.8	6.6	4.9	7.1
K + Macro	8.5	4.6	2.9	5.3	7.8	5.0	4.9	5.9
E + Mi + Ma	8.3	4.6	4.1	5.7	8.5	6.9	5.1	6.8
K + Mi + Ma	5.6	3.4	2.6	3.9	6.1	5.7	4.1	5.3
Mean (A)	12.7	8.3	6.1		12.7	9.9	7.5	
LSD at 5%	A: 0.4	B: 0.7	AB: 1.4		A: 2.0	B: 1.8	AB: 3.6	

1- N : P : K = 500g mineral N, 225g P_2O_5 and 360g K_2O /tree/year.
2- N : P+ : K = 500g mineral N. 150g P_2O_5 + 75g phosphorine and 360g K_2O /tree/year.
3- N+ : P : K = 340g mineral N + 160g Minia azoten, 225g P_2O_5 and 360g K_2O /tree/year.

Under the experimental conditions, the trees suffered from relatively high calcium bicarbonates levels in the soil (Tab.1), which may negatively affect the availability of potassium and other nutrients to the trees. Potassium deficiency resuls in small, thin-skinned fruit and promotes fruit splitting (Tucker *et al.*, 1994). The availability of mineral to the plants was enhanced by biofertilizers (Estefanous and Sawan, 2002).

Moreover, the levels of mineral N and P fertilization were lower in biofertilization than positive control treatments and this may also another reason for the low percentage of fruit splitting in biofertilization treatments. El-Kassas (1983a and 1983b) mentioned that number of cracked fruits of 'Manfalouty' pomegranates was increased as a result of mineral nitrogen and phosphorus fertilization. It seemed that mineral N had negatively greater effect than mineral P in fruit splitting, thereby Azotien treatment which had low rate of mineral N was found more efficient in this regard than phosphorine treatment which included low rate of mineral P.

Also, Tucker *et al.*, (1994) attributed the problem of fruit splitting to water stress and imbalance. Bio-fertilization treatments could be effective in controlling the problem of fruit splitting due to their positive effect in improving soil organic matter, in particular sandy soil. ATTRA, 1999 reported that a healthy soil high in organic matter would have better water and nutrient holding capacity. Biofertilizers improved soil water relations (Graham and Syvertsen, 1984).

Effect of foliar treatments on fruit splitting and sunburn.

Foliar spray treatments greatly affected both splitting and sunburn damage of the pomegranates. In comparison to the control (water sprayed trees), all tested sprays sharply reduced percentages of both problems, in both seasons (Tables 3 and 4). The most effective single solution in decreasing such two phenomena was kaolin followed by macronutrients, micronutrients and finally tocopherol sprays. The mixture of kaolin, micro and macronutrients was the best effective treatment in this respect.

Kaolin-treated pomegranates were less prone to sunburn damage than untreated ones due to reducing both fruit temperature and exposure to UV radiation, as Kaolin has also been found to reflect UVA radiation strongly (Glenn *et al.*, 2002). Melgarejo, (2004) found that sunburn damage of pomegranate fruits was reduced from 21.9% in untreated control to 9.4% in the kaolin-treated fruits. He attributed such effect to its positive role in reducing fruit and leaf surface temperatures. Curry *et al.*, (2004) reported that kaolin reduced solar radiation injury of apple fruits.

ATTRA, 1999 also reported that kaolin protected fruits from heat stress by leaving a protective powdery film on the surfaces of the fruits. Grange *et al.*, (2002) reported that M-97-009 (100% kaolin) was found to be effective in reducing sunburn on all tested cultivars of apples.

Fruit splitting occurs as a result of direct water loss through the fruit skin and/or irregular water supply to plant roots (Wojcik 1999). The kaolin treated fruit being cooled by the applications, leading to reduced fruit water loss (Kerns and Wright, 2000).

Macronutrients were found to be important in checking the problem of fruit splitting after kaolin. This is mainly due to the role of both calcium and magnesium as constituents of cell walls in the form of calcium and magnesium pectates. Firming of the cell wall resulting from addition of Ca & Mg have been attributed to the stabilization of membrane systems and the formation of Ca & Mg - pectates, which increase rigidity of the middle lamella and cell wall (Poovaiah, 1986) and to improved turgor pressure (Mignani *et al.*, 1995). So Ca & Mg could get into the fruits and strengthening the bonds between epidermal and other fruit cells resulting in better strength and low cracking.

Soil analysis (Table 1) show that, the soil was very poor in macro and micronutrients contents due to the high content of sand. Therefore, compensating the trees from the deficient status of these nutrients in the soil by giving them via leaves were efficient in decreasing sunburn and splitting percentages of pomegranate fruits. Tucker *et al.*, (1994) attributed fruit splitting to severe copper deficiency. Wojcik (1999) stated that two foliar sprays of boric acid decreased sensitivity of prune fruits to cracking.

Similar results were obtained by Abdel-Aziz *et al.*, (2001) on "Manfalouty" pomegranate trees grown under sandy soil conditions.

Effect of soil treatments on yield and physical properties of the fruits

Both of biofertilization treatments significantly decreased number of fruits per tree compared to control (100% mineral N and P) (Tab. 5). The lowest fruit numbers was found in Azotien treated trees. Such reduction might be due to low fruit set %.

Table 5: Effect of various foliar and soil treatments on number of fruits per "Manfalouty" pomegranate tree during 2006 and 2007 seasons.

Treatments	Number of fruits /tree							
	2006				2007			
	N:P:K	N:P+:K	N+:P:K	Mean (B)	N:P:K	N:P+:K	N+:P:K	Mean (B)
Control	76.1	61.9	47.2	61.7	91.0	93.4	73.7	86.0
T-pherol (V.E)	80.3	72.0	54.5	68.9	109.7	103.3	78.0	97.0
Kaolin	83.8	78.2	59.1	73.7	132.9	116.3	77.7	109.0
Micronutrients	100.1	91.7	75.6	89.1	132.3	111.3	105.7	116.4
Macronutrients	90.3	89.0	68.3	82.6	111.0	109.3	85.5	101.9
E + Micro	109.0	102.2	89.2	100.1	134.7	130.4	113.0	126.0
E + Macro	96.9	90.0	76.9	87.9	119.7	116.7	100.7	112.3
K + Micro	112.9	107.7	95.4	105.3	160.8	163.3	125.7	149.9
K + Macro	104.4	97.2	84.5	95.3	114.3	150.0	110.3	124.9
E + Mi + Ma	127.3	119.2	109.2	118.6	180.0	171.7	131.1	160.9
K + Mi + Ma	148.0	133.1	116.4	132.5	180.3	160.8	139.0	160.0
Mean (A)	102.6	94.8	79.7		133.3	129.7	103.7	
LSD at 5%	A: 2.4	B: 9.1		AB: NS	A: 11.7	B: 12.4		AB: NS

1- N : P : K = 500g mineral N, 225g P_2O_5 and 360g K_2O /tree/year.

2- N : P+ : K = 500g mineral N, 150g P_2O_5 + 75g phosphorine and 360g K_2O /tree/year.

3- N+ : P : K = 340g mineral N + 160g Minia azoten, 225g P_2O_5 and 360g K_2O /tree/year.

After first batch of fertilization, positive control trees may receive their requirements of N and P faster than bio-fertilized trees, where the effect of bio-fertilizers seemed to be slowly and extended. Therefore, trees receiving the amount of first batch in mineral form only gave better fruit set%. Although high fruit set was attained in trees of positive control but they gave similar final yield to that of biofertilized trees especially those receiving phosphorine (Tab.7). Phosphorine treatments resulted in slightly higher total yield per trees than positive control treatment, in the second experimental season. This is mainly due to the effect of biofertilizers in increasing the average fruit weight per tree (Tab. 6).

Table 6: Effect of various foliar and soil treatments on mean fruit weight of "Manfalouty" pomegranate trees during 2006 and 2007 seasons.

Treatments	Mean fruit weight (g)							
	2006				2007			
	N:P:K	N:P+:K	N+:P:K	Mean (B)	N:P:K	N:P+:K	N+:P:K	Mean (B)
Control	343.9	412.2	403.0	386.4	320.0	456.5	449.0	408.5
T-pherol (V.E)	405.6	479.8	471.7	452.4	350.0	445.8	477.5	424.4
Kaolin	398.5	463.7	467.5	443.3	340.0	425.3	446.7	404.0
Micronutrients	491.1	516.1	499.3	502.2	457.5	485.2	476.9	473.2
Macronutrients	473.5	493.1	491.2	485.9	433.7	446.0	450.0	443.2
E + Micro	511.6	536.6	523.2	523.8	487.5	487.5	477.5	484.2
E + Macro	494.5	500.4	495.3	496.8	447.4	468.0	425.8	447.1
K + Micro	465.1	516.2	499.4	493.6	433.2	450.8	425.0	436.3
K + Macro	465.8	483.7	483.3	477.6	397.5	454.2	401.7	417.8
E + Mi + Ma	466.1	489.9	475.9	477.3	427.1	470.8	462.5	453.5
K + Mi + Ma	455.1	464.5	459.2	459.6	441.7	470.0	448.9	453.5
Mean (A)	451.9	486.9	479.0		412.3	460.0	449.2	
LSD at 5%	A: 11.4	B: 21.8		AB: NS	A: 19.5	B: 22.1		AB: 44.2

1- N : P : K = 500g mineral N, 225g P_2O_5 and 360g K_2O /tree/year.
2- N : P+ : K = 500g mineral N, 150g P_2O_5 + 75g phosphorine and 360g K_2O /tree/year.
3- N+ : P : K = 340g mineral N + 160g Minia azoten, 225g P_2O_5 and 360g K_2O /tree/year.

Biofertilizers increased both weights of arils (data not shown) and peel compared with positive control, in both seasons (Table 8) . Such increase was more obvious in peel weight than in arils weight resulted in less arils/peel ratio (Tab. 9). The effect of biofertilizers in this respect may give an additional reason for its positive effect in decreasing fruit splitting. Fernandes *et al*., (2003) reported that treatments consisting of biofertilizers developed fruits with greater rind thickness than the thickness in fruits from mineral treatments.

They also added that biofertilizers had no significant effect on total yield per plant. Application of Azotobacter, G. fasciculatum, Azospirillum, phosphobacteria and 50% of the recommended dose of NPK recorded the heaviest fruit weight and pulp weight in custard apple (Balakrishnan *et al.*, 2001), while increased fruit yield.

Table 7: Effect of various foliar and soil treatments on total yield per "Manfalouty" pomegranate tree during 2006 and 2007 seasons.

Treatments	Fruit yield (kg) /tree							
	2006				2007			
	N:P:K	N:P+:K	N+:P:K	Mean (B)	N:P:K	N:P+:K	N+:P:K	Mean (B)
Control	25.9	25.3	19.0	23.4	29.1	42.6	33.1	34.9
T-pherol (V.E)	32.6	34.5	25.7	30.9	38.4	46.1	37.2	40.6
Kaolin	33.2	36.1	27.6	32.3	45.2	49.5	34.7	43.1
Micronutrients	49.2	47.3	37.7	44.7	60.5	54.0	50.4	55.0
Macronutrients	42.7	43.8	33.5	40.0	48.1	48.8	38.5	45.1
E + Micro	55.7	54.8	46.7	52.4	65.7	63.6	54.0	61.1
E + Macro	47.5	45.1	38.1	43.6	53.5	54.6	42.9	50.3
K + Micro	52.3	55.5	47.6	51.8	69.7	73.6	53.4	65.6
K + Macro	48.5	47.0	40.8	45.4	45.4	68.1	44.3	52.6
E + Mi + Ma	59.2	58.4	52.0	56.5	76.9	80.8	60.6	72.8
K + Mi + Ma	67.3	61.8	53.5	60.9	79.7	75.6	62.4	72.5
Mean (A)	46.7	46.3	38.4		55.7	59.8	46.5	
LSD at 5%	A: 2.2	B: 4.2		AB 8.4	A: 6.4	B: 7.5		AB 15.0

1- N : P : K = 500g mineral N, 225g P_2O_5 and 360g K_2O /tree/year.
2- N : P+ : K = 500g mineral N, 150g P_2O_5 + 75g phosphorine and 360g K_2O /tree/year.
3- N+ : P : K = 340g mineral N + 160g Minia azoten, 225g P_2O_5 and 360g K_2O /tree/year.

Effect of foliar spray treatments on yield and physical properties of the fruits

Number of fruits and total yield per each tree were improved by foliar spray treatments (Tables 5 and 7). Yield was doubled and more in some treatments compared with water sprayed trees.

Micronutrients were better than other single treatments, in this respect, while tocopherol spray was the least effective treatment. The maximum yield was obtained from the mixture containing kaolin, micro and macronutrient solutions.

Mean weight of fruit, arils and peel were greatly improved by foliar spray treatments. Micronutrient solution was superior to the other single treatments, in this respect (Tables 6 and 8). The heaviest fruits were obtained when micronutrients combined with tocopherol treatment.

Table 8: Effect of various foliar and soil treatments on peel weight of "Manfalouty" pomegranate fruits during 2006 and 2007 seasons.

Treatments	Peel weight (g)							
	2006				2007			
	N:P:K	N:P+:K	N+:P:K	Mean (B)	N:P:K	N:P+:K	N+:P:K	Mean (B)
Control	140.2	171.2	176.5	162.6	117.8	184.0	173.2	158.3
T-pherol (V.E)	162.7	210.0	203.9	192.2	126.2	171.4	184.5	160.7
Kaolin	177.9	219.2	234.9	210.7	115.4	164.1	182.0	153.8
Micronutrients	242.9	267.8	252.8	254.5	226.8	224.8	211.6	221.1
Macronutrients	230.9	244.6	227.9	234.5	172.4	187.3	185.1	181.6
E + Micro	247.5	264.3	249.5	253.8	202.8	213.1	210.7	208.9
E + Macro	218.2	239.0	244.2	233.8	174.6	206.0	188.0	189.5
K + Micro	235.3	246.1	229.8	237.0	206.6	191.5	223.7	207.3
K + Macro	209.2	227.2	227.0	221.2	176.5	202.9	173.2	184.2
E + Mi + Ma	211.5	251.2	222.7	228.4	194.8	213.4	191.5	199.9
K + Mi + Ma	213.3	239.1	226.4	226.3	177.9	210.2	191.2	193.1
Mean (A)	208.1	234.5	226.9		172.0	197.2	192.2	
LSD at 5%	A: 8.9	B: 17.1	AB: NS		A: 7.7	B: 11.6	AB: 23.2	

1- N : P : K = 500g mineral N, 225g P_2O_5 and 360g K_2O /tree/year.

2- N : P+ : K = 500g mineral N, 150g P_2O_5 + 75g phosphorine and 360g K_2O /tree/year.

3- N+ : P : K = 340g mineral N + 160g Minia azoten, 225g P_2O_5 and 360g K_2O /tree/year.

Arils /peel ratio (edible /non-edible portion) was decreased by foliar treatments that contained micro or macro-nutrients, in both seasons (Tab. 9). Therefore, micronutrients were very effective in improving the yield and physical quality of pomegranates. As shown in Table 1 an extreme deficient in micronutrients we observed in the soil of the experiment. Also, relatively high lime levels were observed which could be considered an additional reason for the great suffering from micronutrients deficiency, particularly iron. Therefore, adding iron as a foliar spray was beneficial in giving the trees their requirement of this element for better growth and yield. Also, both zinc and boron are important in the germination of pollen grains and improving the pollination and fertilization process (El-Shazly 1999), who also added that zinc is a precursor of the natural plant hormone, IAA. Boron deficiency, however, is often followed by Ca deficiency. The author also reported that Mn and Cu are important in stimulating many of the necessary enzymes in plant tissue and play a great role in chlorophyll formation. Copper is also found to be important in increasing the ability of plant defense against fungus diseases. The previous great roles of micronutrients are mainly explaining their positive action on the yield and physical characters of pomegranates when they sprayed on trees originally suffers from micronutrients deficiency.

The importance of Ca and Mg as constituents of chlorophyll molecule as well as role of Ca in cell division and pollen grain germination (El-Shazly, 1999) may explain the effect of the tested macronutrients in improving the total yield and physical characters of the fruits.

Abdel-Aziz *et al.*, (2001) found that foliar sprays of a mixture containing calcium chloride (0.5%), potassium sulphate (0.5%) and boric acid (0.05%) were relatively effective in improving fruit physical quality and total yield of "Manfalouty" pomegranate trees grown under sandy soil conditions.

The reduction of foliage temperature by kaolin treatment may improve net photosynthesis by reducing daytime stomatal closure and daytime respiration (Glenn *et al.*, 2001), especially in hot dry climates, leading to better fruit retention, size, and yield (Glenn *et al.*, 1999). ATTRA (1999) reported that kaolin actually increases net photosynthesis, and can provide secondary benefits to the plants' overall health. It keeps the plants cool so that photosynthesis can continue longer into the afternoon on hot days.

Table 9: Effect of various foliar and soil treatments on edible/non-edible portions of "Manfalouty" pomegranate fruits during 2006 and 2007 seasons.

Treatments	Arils /peel ratio							
	2006				2007			
	N:P:K	N:P+:K	N+:P:K	Mean (B)	N:P:K	N:P+:K	N+:P:K	Mean (B)
Control	1.48	1.41	1.29	1.39	1.72	1.48	1.59	1.60
T-pherol (V.E)	1.50	1.29	1.34	1.37	1.77	1.60	1.59	1.65
Kaolin	1.24	1.11	1.00	1.12	1.95	1.59	1.45	1.66
Micronutrients	1.02	0.93	0.98	0.98	1.02	1.16	1.25	1.14
Macronutrients	1.05	1.02	1.16	1.08	1.52	1.38	1.43	1.44
E + Micro	1.07	1.04	1.10	1.07	1.40	1.29	1.27	1.32
E + Macro	1.27	1.10	1.05	1.14	1.56	1.27	1.27	1.37
K + Micro	1.01	1.10	1.18	1.10	1.10	1.35	0.90	1.12
K + Macro	1.23	1.13	1.14	1.17	1.25	1.24	1.32	1.27
E + Mi + Ma	1.21	0.95	1.14	1.10	1.19	1.21	1.42	1.27
K + Mi + Ma	1.14	0.94	1.04	1.04	1.48	1.24	1.35	1.36
Mean (A)	1.20	1.09	1.13		1.45	1.35	1.35	
LSD at 5%	A: 0.06	B: 0.10	AB: 0.20		A: 0.05	B: 0.12	AB: 0.24	

1- N : P : K = 500g mineral N, 225g P_2O_5 and 360g K_2O /tree/year.
2- N : P+ : K = 500g mineral N, 150g P_2O_5 + 75g phosphorine and 360g K_2O /tree/year.
3- N+ : P : K = 340g mineral N + 160g Minia azoten, 225g P_2O_5 and 360g K_2O /tree/year.

Kaolin did not interfere with photosynthesis or stomatal conductance, and may possess yield enhancement qualities (Kerns and Wright, 2000). The increase in yield of kaolin treated trees might be due to the kaolin treated fruit being cooled by the applications, leading to reduction in water loss and the resultant drop.

Effect of soil treatments on chemical quality of the fruits

In comparison to positive control, using bio-fertilizers resulted in either significant or insignificant decreases in both TSS % and total acidity % as well as an increase in TSS/acid ratio, in the first and second seasons, respectively (Tables 10, 11 and 12). On the other hand, bio-fertilizers improved fruits content of vitamin C, while decreased their content of tannins, in both seasons (Tables 13 and 14).

Table 10: Effect of various foliar and soil treatments on juice content of TSS of "Manfalouty" pomegranates in 2006 and 2007 seasons.

Treatments	TSS (%)							
	2006				2007			
	N:P:K	N:P+:K	N+:P:K	Mean (B)	N:P:K	N:P+:K	N+:P:K	Mean (B)
Control	16.4	15.9	14.9	15.7	15.6	15.0	14.8	15.1
T-pherol (V.E)	15.5	15.5	14.2	15.1	15.0	14.6	15.0	14.9
Kaolin	15.0	15.6	14.1	14.9	15.0	15.0	14.2	14.7
Micronutrients	14.5	15.4	13.5	14.5	14.6	15.2	14.8	14.9
Macronutrients	14.4	14.2	14.6	14.4	14.4	15.0	15.0	14.8
E + Micro	14.3	14.1	14.0	14.1	15.0	14.4	14.5	14.6
E + Macro	14.5	13.7	13.0	13.7	15.0	15.0	14.9	15.0
K + Micro	13.8	14.2	15.0	14.3	15.1	14.8	13.8	14.6
K + Macro	14.7	13.7	12.8	13.7	14.4	15.0	14.8	14.7
E + Mi + Ma	15.3	14.2	14.3	14.6	14.8	14.5	14.2	14.5
K + Mi + Ma	14.6	14.5	13.3	14.1	13.9	12.8	14.2	13.6
Mean (A)	14.8	14.6	14.0		14.8	14.7	14.6	
LSD at 5%	A: 0.3	B: 0.6		AB: NS	A: NS	B: 0.3		AB: NS

1- N : P : K = 500g mineral N, 225g P_2O_5 and 360g K_2O /tree/year.

2- N : P+ : K = 500g mineral N, 150g P_2O_5 + 75g phosphorine and 360g K_2O /tree/year.

3- N+ : P : K = 340g mineral N + 160g Minia azoten, 225g P_2O_5 and 360g K_2O /tree/year.

Decreasing number of fruits in biofertilized trees may be resulted in earlier ripening of the fruits and better quality than mineral-fertilized trees. Similar results were obtained by Balakrishnan *et al.*, (2001) and Fernandes *et al.*, (2003).

Table 11: Effect of various foliar and soil treatments on juice content of total acidity of "Manfalouty" pomegranates in 2006 and 2007 seasons.

Treatments	Acidity (%)							
	2006				2007			
	N:P:K	N:P+:K	N+:P:K	Mean (B)	N:P:K	N:P+:K	N+:P:K	Mean (B)
Control	0.743	0.614	0.598	0.652	0.630	0.582	0.679	0.630
T-pherol (V.E)	0.727	0.630	0.549	0.636	0.679	0.582	0.679	0.646
Kaolin	0.808	0.727	0.663	0.733	0.921	0.776	0.776	0.824
Micronutrients	0.760	0.630	0.646	0.679	0.727	0.630	0.776	0.711
Macronutrients	0.760	0.646	0.614	0.673	0.727	0.776	0.776	0.760
E + Micro	0.792	0.663	0.695	0.716	0.776	0.727	0.679	0.727
E + Macro	0.711	0.679	0.711	0.700	0.824	0.727	0.679	0.743
K + Micro	0.695	0.695	0.776	0.722	0.824	0.776	0.727	0.776
K + Macro	0.743	0.695	0.824	0.754	0.873	0.873	0.776	0.840
E + Mi + Ma	0.727	0.679	0.679	0.695	0.824	0.824	0.727	0.792
K + Mi + Ma	0.727	0.679	0.727	0.711	0.824	0.776	0.727	0.776
Mean (A)	0.745	0.667	0.680		0.784	0.732	0.727	
LSD at 5%	A: 0.038	B: 0.050	AB: NS		A: NS	B: 0.040	AB: NS	

1- N : P : K = 500g mineral N, 225g P_2O_5 and 360g K_2O /tree/year.

2- N : P+ : K = 500g mineral N, 150g P_2O_5 + 75g phosphorine and 360g K_2O /tree/year.

3- N+ : P : K = 340g mineral N + 160g Minia azoten, 225g P_2O_5 and 360g K_2O /tree/year.

Biofertilizers, however, resulted in a significant reduction in N content of the fruit, while did not alter the P content (Tables 15 and 16). Also, a slight increase in K content of fruit was observed due to biofertilization treatments (Tab. 17). As for minerals in the edible portion of total fruits per tree, both biofertilizers, in particular Azotien, unsuspectingly reduced the amount of nitrogen in the arils

Table 12: Effect of various foliar and soil treatments on juice content of TSS /acid ratio of "Manfalouty" pomegranates in 2006 and 2007 seasons.

Treatments	TSS/acid ratio							
	2006				2007			
	N:P:K	N:P+:K	N+:P:K	Mean (B)	N:P:K	N:P+:K	N+:P:K	Mean (B)
Control	22.26	25.94	25.31	24.50	24.75	25.78	21.80	24.11
T-pherol (V.E)	21.54	24.77	26.09	24.13	22.10	25.09	22.10	23.10
Kaolin	18.77	21.71	21.70	20.73	16.28	19.34	18.30	17.97
Micronutrients	19.36	24.85	22.02	22.08	20.08	24.12	19.08	21.09
Macronutrients	19.64	22.32	23.78	21.91	19.80	19.34	19.34	19.49
E + Micro	20.56	21.33	21.34	21.08	19.34	18.56	21.36	20.16
E + Macro	19.91	20.83	18.69	19.81	18.20	20.63	21.95	20.26
K + Micro	19.99	20.50	19.63	20.04	18.32	19.08	18.98	18.79
K + Macro	20.37	19.69	15.62	18.56	16.50	17.19	19.08	17.59
E + Mi + Ma	21.38	21.58	21.14	21.36	17.59	17.96	19.53	18.36
K + Mi + Ma	20.39	21.38	19.80	20.53	16.86	16.50	19.53	17.63
Mean (A)	20.38	22.26	21.38		19.11	20.40	20.09	
LSD at 5%	A: 1.61	B: 3.09	AB: NS		A: NS	B: 2.86	AB: NS	

1- N : P : K = 500g mineral N, 225g P_2O_5 and 360g K_2O /tree/year.
2- N : P+ : K = 500g mineral N, 150g P_2O_5 + 75g phosphorine and 360g K_2O /tree/year.
3- N+ : P : K = 340g mineral N + 160g Minia azoten, 225g P_2O_5 and 360g K_2O /tree/year.

of the whole fruits per tree as compared with positive control treatment (Tab. 18). Such reduction was not significant in the second season, only with phosphorine treatment. Phosphorine also did not alter both P and K content of whole fruits in the first season, while improved their amounts in the second season either non-significantly or significantly for both elements, respectively (Tables 19 and 20).

Table 13: Effect of various foliar and soil treatments on juice content of vitamin C of "Manfalouty" pomegranates in 2006 and 2007 seasons.

Treatments	Vitamin C (mg /100g FW)							
	2006				2007			
	N:P:K	N:P+:K	N+:P:K	Mean (B)	N:P:K	N:P+:K	N+:P:K	Mean (B)
Control	0.40	0.43	0.47	0.43	0.57	0.57	0.43	0.53
T-pherol (V.E)	0.47	0.47	0.54	0.49	0.75	0.75	0.65	0.72
Kaolin	0.50	0.82	0.54	0.62	0.75	0.97	0.93	0.88
Micronutrients	0.54	0.47	0.50	0.50	0.75	0.93	0.90	0.86
Macronutrients	0.54	0.57	0.57	0.56	0.54	0.93	0.93	0.80
E + Micro	0.50	0.57	0.75	0.61	0.72	0.90	0.75	0.79
E + Macro	0.50	0.50	0.54	0.51	0.65	0.72	0.65	0.67
K + Micro	0.50	0.50	0.57	0.53	0.75	0.90	0.57	0.74
K + Macro	0.54	0.72	0.68	0.65	0.57	0.93	0.86	0.79
E + Mi + Ma	0.50	0.57	0.43	0.50	0.72	0.68	0.79	0.73
K + Mi + Ma	0.61	0.61	0.57	0.60	0.50	0.86	0.82	0.73
Mean (A)	0.51	0.57	0.56		0.66	0.83	0.75	
LSD at 5%	A: 0.05	B: 0.09	AB: 0.18		A: 0.08	B: 0.12	AB: 0.24	

1- N : P : K = 500g mineral N, 225g P_2O_5 and 360g K_2O /tree/year.

2- N : P+ : K = 500g mineral N, 150g P_2O_5 + 75g phosphorine and 360g K_2O /tree/year.

3- N+ : P : K = 340g mineral N + 160g Minia azoten, 225g P_2O_5 and 360g K_2O /tree/year.

The reduction or no changes of these minerals in fruit arils due to biofertilizer treatments might be attributed to one or more of the following reasons:

1. Use of these minerals in forming new tissues or supporting of pomegranate rind, which led to low splitting. Chavan *et al.*, (1995) found about three fold higher in minerals of pomegranate rind than in arils. As previously mentioned, the tested biofertilizers positively affected mean fruit weight especially rind weight, which led to low arils /peel ratio.
2. Leaching of these minerals by irrigation water, inoculation with mycorrhizal fungi has been shown to enhance, although indirectly,

the solubilization of organic P (Schubert and Lubraco, 2000), and this may have provided more soluble P in inoculated pots, which could be leached by irrigation water.

3. Biofertilizers may have slow and accumulated positive effect, which could be shown from their improving effect on fruit minerals content in the second season compared with the first one, especially with phosphorine treatment.
4. Biofertilizers may have other positive actions on plant growth than mineral uptake. The growth enhancement of Mycorrhizal inoculation can be due to factors other than improved P uptake, such as improved water relations (Graham and Syvertsen, 1984) and protection against root pathogens (Linderman, 1994).

Table 14: Effect of various foliar and soil treatments on juice content of tannins of "Manfalouty" pomegranates in 2006 and 2007 seasons.

Treatments	Tannins (%)							
	2006				2007			
	N:P:K	N:P+:K	N+:P:K	Mean (B)	N:P:K	N:P+:K	N+:P:K	Mean (B)
Control	0.24	0.24	0.21	0.23	0.25	0.19	0.20	0.21
T-pherol (V.E)	0.26	0.24	0.21	0.24	0.24	0.22	0.19	0.22
Kaolin	0.27	0.26	0.25	0.26	0.24	0.21	0.20	0.22
Micronutrients	0.25	0.24	0.23	0.24	0.25	0.24	0.21	0.23
Macronutrients	0.30	0.27	0.25	0.27	0.22	0.18	0.22	0.21
E + Micro	0.29	0.29	0.24	0.27	0.24	0.22	0.22	0.23
E + Macro	0.30	0.26	0.24	0.27	0.26	0.2	0.22	0.23
K + Micro	0.32	0.29	0.28	0.30	0.24	0.21	0.19	0.21
K + Macro	0.26	0.26	0.27	0.27	0.27	0.23	0.19	0.23
E + Mi + Ma	0.27	0.24	0.26	0.26	0.25	0.27	0.22	0.25
K + Mi + Ma	0.27	0.28	0.27	0.27	0.27	0.25	0.20	0.24
Mean (A)	0.27	0.26	0.25		0.25	0.22	0.21	
LSD at 5%	A: 0.02	B: 0.03	AB: NS		A: 0.02	B: 0.03	AB: NS	

1- N : P : K = 500g mineral N, 225g P_2O_5 and 360g K_2O /tree/year.
2- N : P+ : K = 500g mineral N, 150g P_2O_5 + 75g phosphorine and 360g K_2O /tree/year.
3- N+ : P : K = 340g mineral N + 160g Minia azoten, 225g P_2O_5 and 360g K_2O /tree/year.

Table 15: Effect of various foliar and soil treatments on arils content of nitrogen (on fresh weight basis) of "Manfalouty" pomegranates in 2006 and 2007 seasons.

Treatments	N (%)							
	2006				2007			
	N:P:K	N:P+:K	N+:P:K	Mean (B)	N:P:K	N:P+:K	N+:P:K	Mean (B)
Control	0.234	0.193	0.174	0.200	0.212	0.206	0.202	0.207
T-pherol (V.E)	0.234	0.215	0.174	0.208	0.218	0.218	0.214	0.217
Kaolin	0.248	0.235	0.187	0.223	0.216	0.218	0.217	0.217
Micronutrients	0.309	0.270	0.263	0.281	0.282	0.268	0.231	0.260
Macronutrients	0.303	0.245	0.239	0.262	0.266	0.241	0.222	0.243
E + Micro	0.299	0.250	0.239	0.263	0.261	0.250	0.236	0.249
E + Macro	0.290	0.238	0.228	0.252	0.256	0.242	0.231	0.243
K + Micro	0.282	0.252	0.289	0.274	0.256	0.243	0.227	0.242
K + Macro	0.261	0.228	0.217	0.235	0.258	0.231	0.215	0.235
E + Mi + Ma	0.270	0.258	0.245	0.258	0.266	0.248	0.231	0.248
K + Mi + Ma	0.292	0.265	0.251	0.269	0.270	0.237	0.234	0.247
Mean (A)	0.275	0.241	0.228		0.251	0.237	0.224	
LSD at 5%	A: 0.031	B: 0.026		AB: NS	A: 025	B: 0.019		AB: NS

1- N : P : K = 500g mineral N, 225g P_2O_5 and 360g K_2O /tree/year.
2- N : P+ : K = 500g mineral N, 150g P_2O_5 + 75g phosphorine and 360g K_2O /tree/year.
3- N+ : P : K = 340g mineral N + 160g Minia azoten, 225g P_2O_5 and 360g K_2O /tree/year.

Effect of foliar spray treatments on chemical quality of the fruits

Fruits content of TSS was reduced by all foliar sprays (Tab. 10). The highest reduction was obtained with using the mixture of kaolin, micro and macronutrient treatments. On the other hand, all treatments signficantly raised fruits content of total acidity resulting in low TSS /acid ratio except tocopherol solution (Tables 11 and 12). Such result indicated that using these treatments delayed to a lesser or greater extent the pomegranate fruit maturity according to the tested solution.

Table 16: Effect of various foliar and soil treatments on arils content of phosphorus (on fresh weight basis) of "Manfalouty" pomegranates in 2006 and 2007 seasons.

Treatments	P (%)							
	2006				2007			
	N:P:K	N:P+:K	N+:P:K	Mean (B)	N:P:K	N:P+:K	N+:P:K	Mean (B)
Control	0.027	0.037	0.032	0.032	0.035	0.038	0.028	0.033
T-pherol (V.E)	0.038	0.041	0.038	0.039	0.035	0.043	0.042	0.040
Kaolin	0.042	0.047	0.042	0.044	0.039	0.038	0.039	0.039
Micronutrients	0.036	0.037	0.040	0.038	0.039	0.039	0.040	0.039
Macronutrients	0.040	0.041	0.040	0.040	0.040	0.036	0.040	0.039
E + Micro	0.046	0.044	0.047	0.047	0.040	0.038	0.035	0.038
E + Macro	0.037	0.036	0.030	0.034	0.039	0.041	0.042	0.041
K + Micro	0.037	0.038	0.045	0.040	0.035	0.041	0.040	0.039
K + Macro	0.044	0.045	0.040	0.043	0.040	0.036	0.036	0.037
E + Mi + Ma	0.036	0.035	0.032	0.034	0.035	0.044	0.041	0.040
K + Mi + Ma	0.047	0.040	0.030	0.039	0.040	0.039	0.039	0.039
Mean (A)	0.039	0.040	0.038		0.038	0.040	0.038	
LSD at 5%	A: NS	B: 0.006		AB: NS	A: NS	B: 0.005		AB: NS

1- N : P : K = 500g mineral N, 225g P_2O_5 and 360g K_2O /tree/year.
2- N : P+ : K = 500g mineral N, 150g P_2O_5 + 75g phosphorine and 360g K_2O /tree/year.
3- N+ : P : K = 340g mineral N + 160g Minia azoten, 225g P_2O_5 and 360g K_2O /tree/year.

Delaying fruit ripening by foliar spray treatments may be due to their effects in increasing number of fruits per tree.

All foliar treatments improved fruits content of vitamin C and resulted in higher values of tannins than the control (Tables 13 and 14). Fruit tannin content may be raised due to the delay in fruit ripening.

Both N and K percentages in the fruits were greatly enhanced by foliar solutions especially those containing micro and macro-nutrients, in both seasons (Tables 15 and 17). Also, P percentage was improved in almost foliar treatments as compared with the control (Tab. 16). Moreover, all tested treatments increased the contribution of

Table 17: Effect of various foliar and soil treatments on arils content of potassium (on fresh weight basis) of "Manfalouty" pomegranates in 2006 and 2007 seasons.

Treatments	K (%)							
	2006				2007			
	N:P:K	N:P+:K	N+:P:K	Mean (B)	N:P:K	N:P+:K	N+:P:K	Mean (B)
Control	0.244	0.246	0.300	0.263	0.294	0.288	0.357	0.313
T-pherol (V.E)	0.255	0.264	0.302	0.274	0.320	0.313	0.339	0.324
Kaolin	0.263	0.285	0.340	0.296	0.319	0.330	0.341	0.330
Micronutrients	0.319	0.365	0.339	0.341	0.362	0.355	0.359	0.359
Macronutrients	0.289	0.349	0.323	0.320	0.350	0.344	0.359	0.351
E + Micro	0.282	0.323	0.268	0.291	0.380	0.404	0.372	0.385
E + Macro	0.331	0.262	0.343	0.312	0.358	0.351	0.418	0.376
K + Micro	0.346	0.296	0.256	0.299	0.335	0.406	0.379	0.373
K + Macro	0.267	0.324	0.261	0.284	0.360	0.418	0.342	0.373
E + Mi + Ma	0.273	0.283	0.296	0.284	0.357	0.366	0.386	0.370
K + Mi + Ma	0.345	0.341	0.341	0.342	0.363	0.329	0.346	0.346
Mean (A)	0.292	0.303	0.306		0.345	0.355	0.364	
LSD at 5%	A: NS	B: 0.022		AB: NS	A: NS	B: 0.020		AB: NS

1- N : P : K = 500g mineral N, 225g P_2O_5 and 360g K_2O /tree/year.
2- N : P+ : K = 500g mineral N, 150g P_2O_5 + 75g phosphorine and 360g K_2O /tree/year.
3- N+ : P : K = 340g mineral N + 160g Minia azoten, 225g P_2O_5 and 360g K_2O /tree/year.

whole fruits per each treated tree to more amounts of N, P and K than those of control tree. This may give an indication for their positive effect in improving the nutritional status of pomegranate trees grown under sandy soil conditions. The highest values of these mineral were recorded in fruits of trees treated with mixture of kaolin, micro and macronutrients, in both seasons (Tables 18, 19 and 20). Kaolin uniquely suitable for protecting pomegranate fruit quality (Melgarejo *et al.*, 2004). Also, the important role of macro and micronutrients in improving the nutritional status of pomegranate trees grown under sandy soil reflected in better fruit quality.

Table 18: Effect of various foliar and soil treatments on nitrogen of whole fruit arils (on fresh weight basis) per "Manfalouty" pomegranate tree in 2006 and 2007 seasons.

Treatments	N in edible portion (g/tree)							
	2006				2007			
	N:P:K	N:P+:K	N+:P:K	Mean (B)	N:P:K	N:P+:K	N+:P:K	Mean (B)
Control	36.3	28.8	18.6	27.9	39.1	52.4	41.1	44.2
T-pherol (V.E)	45.6	41.8	25.4	37.6	53.5	61.8	48.9	54.7
Kaolin	45.9	45.0	25.7	38.8	64.5	66.2	44.6	58.4
Micronutrients	76.8	61.5	49.0	62.4	86.1	77.7	64.8	76.2
Macronutrients	66.4	54.2	43.0	54.5	77.2	68.1	50.3	65.2
E + Micro	86.1	69.6	58.4	71.3	100.1	89.5	71.2	86.9
E + Macro	77.6	56.0	44.0	59.2	83.6	74.0	55.3	71.0
K + Micro	73.2	73.3	74.4	73.6	93.3	102.9	57.4	84.5
K + Macro	69.9	56.8	47.0	57.9	65.2	87.1	54.2	68.8
E + Mi + Ma	87.5	73.5	67.8	76.2	111.2	109.6	82.1	101.0
K + Mi + Ma	104.5	79.5	68.0	84.0	128.4	99.0	83.8	103.8
Mean (A)	70.0	58.2	47.4		82.0	80.8	59.4	
LSD at 5%	A: 6.6	B: 5.9		AB: 11.8	A: 5.7	B: 4.6		AB: 9.2

1- N : P : K = 500g mineral N, 225g P_2O_5 and 360g K_2O /tree/year.
2- N : P+ : K = 500g mineral N, 150g P_2O_5 + 75g phosphorine and 360g K_2O /tree/year.
3- N+ : P : K = 340g mineral N + 160g Minia azoten, 225g P_2O_5 and 360g K_2O /tree/year.

Table 19: Effect of various foliar and soil treatments on phosphorus of whole fruit arils (on fresh weight basis) per "Manfalouty" pomegranate tree in 2006 and 2007 seasons.

Treatments	P in edible portion (g/tree)							
	2006				2007			
	N:P:K	N:P+:K	N+:P:K	Mean (B)	N:P:K	N:P+:K	N+:P:K	Mean (B)
Control	4.2	5.5	3.4	4.4	6.4	9.7	5.7	7.3
T-pherol (V.E)	7.4	8.0	5.6	7.0	8.6	12.2	9.6	10.1
Kaolin	7.8	9.0	5.8	7.5	11.6	11.5	8.0	10.4
Micronutrients	8.9	8.4	7.5	8.3	11.9	11.3	11.2	11.5
Macronutrients	8.8	9.1	7.2	8.3	11.6	10.2	9.1	10.3
E + Micro	13.2	12.3	11.5	12.3	15.3	13.6	10.6	13.2
E + Macro	9.9	8.5	5.8	8.1	12.7	12.5	10.1	11.8
K + Micro	9.6	11.1	11.6	10.1	12.8	17.4	10.1	13.4
K + Macro	11.8	11.2	8.7	10.6	9.1	15.1	9.1	11.1
E + Mi + Ma	11.7	10.0	8.9	10.2	14.6	19.5	14.6	16.2
K + Mi + Ma	16.8	12.0	8.1	12.3	19.0	16.3	14.0	16.4
Mean (A)	10.0	9.5	7.6		12.2	13.6	10.2	
LSD at 5%	A: 1.3	B: 2.6		AB: 5.2	A: 1.1	B: 1.9		AB: 3.8

1- N : P : K = 500g mineral N, 225g P_2O_5 and 360g K_2O /tree/year.
2- N : P+ : K = 500g mineral N, 150g P_2O_5 + 75g phosphorine and 360g K_2O /tree/year.
3- N+ : P : K = 340g mineral N + 160g Minia azoten, 225g P_2O_5 and 360g K_2O /tree/year.

Table 20: Effect of various foliar and soil treatments on potassium of whole fruit arils (on fresh weight basis) per "Manfalouty" pomegranate tree in 2006 and 2007 seasons.

Treatments	K in edible portion (g/tree)							
	2006				2007			
	N:P:K	N:P+:K	N+:P:K	Mean (B)	N:P:K	N:P+:K	N+:P:K	Mean (B)
Control	37.8	36.7	32.1	35.5	54.1	73.3	72.6	66.7
T-pherol (V.E)	49.7	51.3	44.1	48.4	78.6	88.7	77.5	81.6
Kaolin	48.6	54.5	46.7	50.0	95.2	100.3	70.1	88.5
Micronutrients	79.3	83.1	63.2	75.2	110.5	102.9	100.7	104.7
Macronutrients	63.3	77.2	58.1	66.2	101.5	97.3	81.3	93.4
E + Micro	81.2	89.9	65.4	78.9	145.7	144.6	112.2	134.2
E + Macro	88.6	61.6	66.3	72.2	116.9	107.3	100.1	108.1
K + Micro	89.8	86.1	65.9	80.6	122.1	171.9	95.9	130.0
K + Macro	71.5	80.8	56.5	69.6	90.9	157.6	86.2	111.6
E + Mi + Ma	88.5	80.6	81.9	83.6	149.3	161.8	137.1	149.4
K + Mi + Ma	123.5	102.3	92.4	106.1	172.7	137.4	123.9	144.7
Mean (A)	74.7	73.1	61.1		112.5	122.1	96.1	
LSD at 5%	A: 6.2	B: 5.6		AB: 11.2	A: 5.7	B: 4.8		AB: 9.6

1- N : P : K = 500g mineral N, 225g P_2O_5 and 360g K_2O /tree/year.

2- N : P+ : K = 500g mineral N, 150g P_2O_5 + 75g phosphorine and 360g K_2O /tree/year.

3- N+ : P : K = 340g mineral N + 160g Minia azoten, 225g P_2O_5 and 360g K_2O /tree/year.

CONCLUSION

The following treatments are recommended for 'Manfalouty' pomegranate trees (7 year) grown in sandy soil: Fertilizing pomegranate trees with 500g mineral N, 150g P_2O_5 + 75g phosphorine and 360g K_2O /tree/year in combination with four sprays of a solution containing kaolin (2%), micronutrients (Chelated form of Fe, Zn and Mn each at 0.1% plus Boric acid at 0.05% & $CuSO_4$ at 0.05%) and macronutrients ($CaCl_2$ & $MgSO_4$ each at 1.0%) at 1st week of May, June, July and August. This was suggested to be the best treatment required for obtaining the maximum marketable and exportable pomegranate fruits.

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محاولات لإيجاد أفضل معاملة لازمة للحصول على ثمار مثالية قابلة للتسويق وأثرها على أمد تخزين ثمار الرمان "المنفلوطي"

١ – تقييم بعض المعاملات الأرضية والورقية على التشقق ، لفحة الشمس ، المحصول وجودة الثمار

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تمتاز ثمار الرمان بقيمتها الغذائية العالية، لكن مشكلتي الانشقاق ولفحة الشمس تعتبران من العوامل الرئيسية التي تُجعل الثمارَ غير مناسبةَ لقبولِ المستهلك. تَعاني الأشجارُ أيضاً منْ إهْمال التغذية المثلى من قبل المزارعين والنقص المعدني خصوصاً في الأرضِ المستصلحة الجديدة، التي تنعكسُ بالتالي في صورة انخفاض المحصول وقلة جوده الثمارِ. لذا، تم اختبار ثلاثة معاملات تربة تتضمن التسميد بالاسمده المعدنية

والحيويةِ بالإضافة إلى أحدَ عشرَ معاملة ورقيةِ منْ مضادات أكسده، مادّة عضوية، بَعْض العناصرِ الكبرى والصغرى على أشجارِ رمانِ صنف 'منفلوطى' عمرها ٧ سنوات نامية في تربةِ رمليةِ لإيجاد حَلّ لهذه المشاكلِ ولتَحسين المحصول وجوده الثمار.

من نتائج هذه الدراسةِ، أن رش الارشجار اربعة مرات (خلَيْط) تتضمن الكاولين (٢ %) ، عناصر صغرى (فى صورة مخلبية للحديد والزنك والمنجنيز كلا بتركيز ٠,١ % بالإضافة إلى حامض البوريك بتركيز ٠,٠٥ % وكبريتات النحاس بتركيز ٠,٠٥ %) و عناصر كبرى (كلوريد كالسيوم ، كبريتات ماغنسيوم كلا بتركيز ١. %) في الأسبوع الأول منْ مايو ، يونيو، يوليو وأغسطس بالإضافة إلى إمداد التربةَ ب ٥٠٠ جرام نيتروجين معدني ، ١٥٠ جرام خامس اكسيد الفوسفور + ٧٥ جرام فوسفورين و٣٦٠ جرام أكسيد البوتاسيوم/ شجرة/ يعطى نَتائِجَ واعِدةَ. تعتبر هذه المعاملة من أفضل المعاملات لإنْتاج محصولِ عالي وثمارِ ذات جوده عالية تكون مناسبةِ لمعاييرِ التصديرَ والسوقَ.