

Original Research Article

Influence of natural alternative NPK and bio-fertilizations on vegetative growth and nutritional status of young wonderful pomegranate trees

ABSTRACT

Aims: Studying the effect of natural alternative NPK and bio fertilizations on vegetative growth and nutritional status of Wonderful pomegranate trees.

Study design: The complete randomized block design with three replications was used for arranging the fertilization treatments and each replicate was represented by two trees.

Place and Duration of Study: This investigation was conducted during two experimental seasons 2014 and 2015 on young Wonderful pomegranate trees grown in reclaimed sandy soil under drip irrigation (National Research Center orchard) at Nobaria region, Behara Governorate, Egypt.

Methodology: Organic N and some natural PK raw mixtures used at four doses (500, 1000, 1500 and 2000 g/tree) either solely or combined with bio NPK fertilizers and evaluated.

Results: Obtained results declared that T₁ (control), T₂ (organo NPK rocky materials only at 500 g/tree) and T₁₀ (bio NPK fertilizers mixture solely at 300 ml/tree) seemed to be equally declined, followed in ascending order by T₃ (1000g of alter. organo. Rocky mix. Only, T₆ (T₂ + 300 ml bio NPK mix.), T₄ (1500g of alter. organo. Rocky mix. Only, T₅ (2000g of alter. organo. Rocky mix. Only), T₇ (T₃ + 300 ml bio NPK mix.) and T₈ (T₄ + 300 ml bio NPK mix.) and T₉ (T₅ + 300 ml bio NPK mix.).

Conclusion: The investigated vegetative growth measurements (plant height, stem thickness, shoot length, No. of both shoots per tree and leaves/shoot, average leaf area and total assimilation area), as well as nutritional status (leaf chlorophyll, N, P, K, Fe, Mn and Zn contents) responded obviously to the fertilization treatments and followed to great extent the same trend.

Keywords: Wonderful pomegranate, natural PK raw, organic N, bio NPK, vegetative growth and nutritional status

1. INTRODUCTION

Pomegranate "*Punica granatum* L." is one of the oldest known edible fruit species mentioned in the Quran. It belongs to the Family Punicaceae, its fruits is considered as a popular desirable rich sources for providing the local consumer with vitamin C, K, fibers and low-calories juice (Fuhrman and Avirman, 2007 and Fawole and Opara, 2013). Moreover, it has also its own great importance in the human medicine purposes as its components have a wide range of available worth clinical applications, (Lanky and Newman, 2007).

Wonderful pomegranate Originated in Florida. First propagated in California in 1896. Large, deep purple-red fruit. Rind medium thick, tough. Flesh deep crimson in color, juicy and of a delicious vinous flavor. Seeds are not very hard. Better for juicing than eating. Plant is

27 vigorous and productive, leading the commercial variety in California. Also, the pomegranate
28 cultivar Wonderful is known for its sweet taste, plentiful juice and health benefits that may
29 help with heart disease, cancer and problems associated with aging. It is loaded with
30 antioxidants, vitamins, potassium, folic acid and iron. This cultivar is widely-cultivated in
31 California, while the last few years, it has replaced the native Greek cultivars. Now,
32 Wonderful is the main pomegranate cultivar in Greece (**Drogoudi et al., 2012**).

33 Because, the principle hoped target by pomegranate growers is usually similar to that of
34 other fruit producers, as well as any of the industrial production processes all are
35 concentrated towards increasing the net grower's or producer's income. Such goal could be
36 practically achieved through increasing productivity associated with higher fruit quality from
37 one hand, and lowering or minimizing cost of the needed horticultural practices especially
38 those related to fertilization from the other. Accordingly, building of a well strong tree canopy
39 structure especially through the earlier orchard establishment stage i.e., juvenile phase of
40 pomegranate trees is a real guaranty for realizing such aimed main factors closely related to
41 increasing productivity and finally pomegranate grower's income could be realized certainly.
42 Besides, decreasing cost of pomegranate production through using other NPK cheaper
43 source/s particularly those having availed option as being economical and environment
44 friendly mineral or bio-fertilizers substances is the second reason by which the expected final
45 goal could be achieved.

46 Consequently, the present work is mainly directed towards investigating the possibility of
47 replacing the expensive, highly dispersible soluble three major commercial concentrated
48 mineral NPK fertilizers usually adopted by an alternative cheaper and environment friendly
49 ones either those of organic or mineral rocky nature, as well as some bio-sources of
50 fertilizers. Since, all alternative sources are characterized by their slow releasing ability of
51 their nutrients content which represents a continuous gradual supply along the growing
52 season around fruit trees. So, the mineral NPK fertilization program adopted in the region
53 according to the recommendation of the Ministry of Agriculture and Land Reclamation in
54 comparison with three other NPK sources i.e., granulated organic N fertilizer of 18-20%
55 actual N, granulated natural mineral rocky material phosphor source of 18-20% actual P_2O_5
56 and granulated natural mineral rocky material potassium source of 10-12% actual K_2O ,
57 besides, three NPK bio-fertilizer sources either as an amendment/addenda practical together
58 with the three alternate NPK fertilizers or alone as an independent treatment (a- Nitrobein, b-
59 Phosphorene and c- Potassein) were investigated in this concern.

61 2. MATERIAL AND METHODS

62
63 The present investigation was conducted during two consecutive 2014 and 2015
64 experimental seasons on young Wonderful pomegranate "*Punica granatum* L." trees (one-
65 year-old) planted at 3x5 meters apart in a new reclaimed sandy soil under drip irrigation
66 system using Nile river water at the Experimental Station Farm of National Research Centre
67 located at Noharia district, El-Behara Governorate, Egypt.

68 The mechanical and chemical analyses of orchard soil were determined after the methods
69 described by **Piper (1958)** and **Jackson (1967)** as shown in **Table (1)**.

70 The main goal was the possibility of replacing the major three expensive mineral
71 concentrated NPK fertilizers with other cheaper and environment friendly natural NPK
72 sources having either mineral, organic or bio nature. So, the ordinary common mineral NPK
73 fertilization regime adopted in the region in the form of ammonium sulphate, superphosphate
74 **Table (1):** Physical and chemical properties of the experiment soil

75

Properties	Value	Properties	Value
Clay %	5.00	P %	0.44
Silt %	5.00	K %	0.57
sand %	90.00	Ca mg/L	2.65
Texture	Sandy	Mg mg/L	2.40
PH	8.20	HCO ₃ mg/L	3.85
EC	1.50	Cl mg/L	53.00
N%	Trace	SO ₄ mg/L	55.65

and potassium sulfate yearly added at the rate of 0.400, 0.400 and 0.200 Kg per tree, respectively was also included as control in this experiment. However, other alternate NPK fertilizer sources were: 1- Granulated organic N fertilizer of 18-20 % actual N*, 2- Two natural raw rocky materials, 1st as P fertilizer of 18-20 % actual P₂O₅ *, while 2nd as K fertilizer of 10-12 % actual K₂O* and 3- Three bio fertilizers ** i.e., a)- Nitrobein:- It is a commercial nitrogenous bio-fertilizer contain specialized bacterial strains for free N fixation, b)- Phosphorene: It is a commercial phosphorus bio-fertilizer containing some active bacterial strains which facilitates P uptake through changing the insoluble tri-calcium phosphate (unavailable form) into available soluble one (mono- Calcium phosphate), and c) – Potassien: It is a commercial potassium bio-fertilizer that facilitates potassium releasing from clay complex components or between their mineral platelet layers. Taking into consideration that three alternate NPK sources i.e., granulated organic N fertilizer and granulated natural raw mineral rocky materials for either P or K fertilizers were mixed together at an equal proportion (1:1:1by weight) to be used as a composite fertilizer mixture.

Soil application was at four doses (500, 1000, 1500 and 2000 g/tree) either solely or combined with three bio-fertilizers mixture, moreover, three bio-fertilizers (Nitrobein, Phosphorene and Potassein) were also mixed together at equal proportions (1:1:1 by volume) for being soil drench applied at the rate of 300 ml/tree either solely or combined to the four investigated doses of the three alternative NPK sources. Accordingly, 10 fertilization treatments which investigated in this experiment were as follows:

- 1- Control (the ordinary mineral NPK fertilization program adopted at 400, 400 and 200 g/tree from (NH₄)₂SO₄, superphosphate and K₂SO₄, respectively) according to the Ministry of Agriculture and Land Reclamation recommendation.
- 2- Natural alternative NPK fertilizations mixture (organic N and PK raw mineral rocky materials) at 500 g per tree.
- 3- Natural alternative NPK fertilizations mixture (organic N and PK raw mineral rocky materials) at 1000 g per tree.
- 4- Natural alternative NPK fertilizations mixture (organic N and PK raw mineral rocky materials) at 1500 g per tree.
- 5- Natural alternative NPK fertilizations mixture (organic N and PK raw mineral rocky materials) at 2000 g per tree.

* Prepared, purified and salad by AL AHRAM MINING COMPONY.

** Prepared and marketing by The Ministry of Agriculture and Land Reclamation.

6- Natural alternative NPK fertilizations mixture (organic N and PK raw mineral rocky materials) at 500 g plus NPK bio-fertilizations mixture at 300 ml. per tree.

114 7- Natural alternative NPK fertilizations mixture (organic N and PK raw mineral rocky
115 materials) at 1000 g plus NPK bio-fertilizations mixture at 300 ml. per tree.
116 8- Natural alternative NPK fertilizations mixture (organic N and PK raw mineral rocky
117 materials) at 1500 g plus NPK bio-fertilizations mixture at 300 ml. per tree.
118 9- Natural alternative NPK fertilizations mixture (organic N and PK raw mineral rocky
119 materials) at 1000 g plus NPK bio-fertilizations mixture at 300 ml. per tree.
120 10- NPK bio-fertilizations mixture solely at 300 ml. per tree.
121 All trees in this experiment were subjected to the same horticultural practices adopted in the
122 farm concerning irrigation regime, micro-elements addenda weed and insect controlling.

123 The complete randomized block design with three replications was used for arranging the
124 abovementioned ten fertilization treatments and each replicate was represented by two
125 trees. Besides, the corresponding fertilizations amount of every treatment was fractionated
126 into three equal doses for being soil applied during each season at one-month interval i.e.,
127 mid. of Feb., March and April for 1st, 2nd and 3rd portions, respectively.

128 Influence of investigated ten fertilization treatments was evaluated as each experimental
129 season had been terminated on late October through determining differences exhibited in
130 the following vegetative growth and nutritional status measurements:

131

132 **2.1 Vegetative growth**

133

134 (Plant height, trunk diameter at 10.0 cm above soil surface, average shoot length in cm.),
135 (No. of shoots/plant and leaves/shoot) and (area of individual leaf and total assimilation
136 surface/shoot) were determined. Whereas, average leaf area was estimated according to the
137 following formula after **Ahmed and Morsy (1999)**: Leaf area = 0.41(leaf length x its width) +
138 1.83.

139

140 **2.2 Nutritional status**

141 In this regard, leaf total chlorophyll, N, P, K, Fe, Mn and Zn contents were determined as
142 follows:

143

144 **2.1.1 Leaf total chlorophyll**

145

146 Leaf total chlorophyll contents were determined in fresh leaves using **Minolta meter SPAD-**
147 **502**.

148

149 **2.1.2 Leaf total (N)**

150

151 Leaf total (N) was determined by the modified micro Kjeldahl method mentioned by **Pregl,**
152 **(1945)**.

153

154 **2.1.3 Leaf total P, K, Fe, Mn and Zn**

155

156 Leaf total P, K, Fe, Mn and Zn were determined after **Chapman and Pratt, (1961)**.

157

158 **Statistical analysis:**

159 All data obtained during both seasons were subjected to analysis of variance according to
160 **Snedecor and Cochran, (1980)** and significant differences among means were
161 distinguishing according to the Duncan's, multiple test range **Duncan, (1955)**.

3. RESULTS AND DISCUSSION

3.1 Vegetative growth measurements during 2015 and 2016 experimental seasons of young Wonderful pomegranate trees in response to NPK fertilization treatments with adopted common, alternate natural, rocky mixture and bio-NPK sources

In this respect, average plant height, trunk diameter, shoot length, No. of shoots/tree, No. of leaves/shoot, leaf area and assimilation area were the seven growth measurements investigated in response to different treatments during both seasons for young Wonderful pomegranate trees are presented in Tables (2) and (3), respectively. It is quite clear to notice that the highest alternate-natural rocky mixture (2000 g) + 300 ml bio-NPK mixture resulted significantly in the highest abovementioned vegetative growth measurements during 2015 and 2016 experimental seasons. Moreover, T8 (1500 g alternate-natural rocky mixture + 300 ml bio-NPK mixture) came statistically the 2nd for all vegetative growth measurements during both seasons. Anyhow, T7 (1000 g alternate natural-rocky mixture + 300 ml bio-NPK mixture) ranked statistically the 3rd, decendingly, followed by T6 (500 g alternate natural-rocky mixture + 300 ml bio-NPK mixture) and T5 (2000 g alternate natural-rocky mixture) as both came the 4th during the two seasons for young Wonderful pomegranate trees. On the contrary, the least significant increase in the abovementioned vegetative growth measurements was also coupled to T1 (Adopted NPK fertilizers in region or control), T2 (500 g of alternate natural-rocky mixture) and T10 (300 ml of bio-NPK mixture) during 2015 and 2016 experimental seasons. In addition, T3 (1000 g of alternate-natural rocky mixture) was in between during the two seasons of study.

The beneficial effect of different NPK fertilization treatments with adopted common, alternate natural-rocky mixture and bio-NPK sources on increasing vegetative growth measurements may be attributed to their positive effect on N absorption that certainly reflected positively on root system growth and consequently its ability to absorb different nutrient elements like P and K. On the other hand, these results goes generally with those found by **Fawzia-Eissa, (2003)** on Canino apricot cv., **Kabeel et al., (2005)** on Canino apricot cv., **Kabeel et al., (2007)** on Anna apple trees, **Stino et al., (2009)** on Canino apricot cv., **Osman and Abd El-Rahman, (2010)** on Fig trees, **Darwish, (2012)** on Costata persimmon trees, **EL-Gioushy, (2016)** on young Manfalouty pomegranate trees and **Amin et al., (2017)** on pomegranate trees.

3.2 Nutritional status measurements during 2015 and 2016 experimental seasons of young Wonderful pomegranate trees in response to NPK fertilization treatments with adopted common, alternate natural-rocky mixture and bio-NPK sources.

In this regard, leaf total chlorophyll, N, P, K, Fe, Mn and Zn contents were the studied nutritional status measurements of young Wonderful pomegranate trees as influenced by different investigated treatments.

Data obtained during both 2015 and 2016 experimental seasons are presented in Tables (4 and 5). It's clear that, all leaf chemical composition of various nutritional status measurements was influenced by the different investigated NPK fertilization treatments. Moreover, the highest alternate natural-rocky mixture at 2000 g + 300 ml of bio-NPK mixture (T5) was statistically the superior, while 300 ml of bio-NPK mixture only (T10) was the inferior as shown the lowest values with all investigated measurements. Such trend was true during 2015 and 2016 experimental seasons. Moreover, T8 (1500 g alternate natural-rocky mixture + 300 ml of bio-NPK mixture) ranked statistically the second, decendingly, followed

214 **Table (2) Plant height, trunk diameter, shoot length and No. of shoots/tree of young**
 215 **Wonderful pomegranate trees in response to NPK fertilization treatments with**
 216 **adopted common*, alternate natural-rocky mixture** and bio-NPK sources*** during**
 217 **2014 and 2015 seasons**
 218

NPK fertilization treatments (source and dose per trees)	Vegetative growth measurements during the two experimental seasons 2014 and 2015							
	Plant height (cm)		Trunk diameter (cm)		Shoot length (cm)		No. of shoots/tree	
	2014	2015	2014	2015	2014	2015	2014	2015
T ₁ - Adopted NPK fert. in region (control)	116.8 h	140.0 h	1.51 g	2.01 f	40.40 g	41.52 g	6.67 hi	11.00 e
T ₂ - 500g of alter. organo. Rocky mix. Only	112.3 j	133.5 i	1.48 h	1.97 g	38.60 h	39.03 h	7.33 h	9.67 f
T ₃ - 1000g of alter. organo. Rocky mix. Only	125.1 g	146.9 g	1.63 f	2.18 e	45.43 f	46.13 f	9.33 g	13.33 d
T ₄ - 1500g of alter. organo. Rocky mix. Only	146.6 e	166.6 e	1.83 e	2.40 d	49.88 e	50.47 e	11.67 e	15.67 c
T ₅ - 2000g of alter. organo. Rocky mix. Only	155.7 d	176.9 d	1.90 d	2.52 c	53.07 d	53.43 d	12.67 d	16.67 c
T ₆ - (T ₂ + 300 ml bio NPK mix.)	133.8 f	157.7 f	1.64 f	1.95 gh	49.37 e	50.23 e	10.33 f	13.33 d
T ₇ - (T ₃ + 300 ml bio NPK mix.)	157.8 c	188.1 c	1.93 c	2.53 c	55.73 c	56.60 c	13.67 c	18.67 b
T ₈ - (T ₄ + 300 ml bio NPK mix.)	182.8 b	196.0 b	1.97 b	2.57 b	57.27 b	58.23 b	17.33 b	19.00 b
T ₉ - (T ₅ + 300 ml bio NPK mix.)	187.8 a	206.4 a	2.10 a	2.66 a	62.15 a	63.72 a	21.67 a	25.67 a
T ₁₀ - 300 ml bio NPK mixture only	114.6 i	138.3 h	1.44 i	1.94 h	39.03 gh	38.90 h	6.33 i	10.33 ef

219 *Means followed by the same letter/s within each column didn't significantly differ at 5% level*

220 **refers to the ordinary adopted NPK fertilizers after recommendation of Min. of Agric.*

221 ***refers to alternative NPK mixture (orange N and natural rocky PK materials at 1:1:1 by weight.*

222 ****refers to bio NPK fertilizers (Nitrobein, phosphorene and potassein) mix. at 1:1:1 by volume.*

223
 224 by those of T5 (2000 g alternate natural-rocky mixture), T7 (1000 g alternate natural-rocky
 225 mixture + 300 ml bio-NPK mixture) and T6 (500 g alternate natural-rocky mixture). However,
 226 differences between T1 (Adopted NPK fertilization in region) and T2 (500 g alternate natural-
 227 rocky mixture) in most cases didn't reach the level of significance as compared with each
 228 other, regardless of young Wonderful pomegranate trees during both seasons. Such trend
 229 was true during the two seasons with very few exceptions.

230 On the other hand, the rate of increase in most nutritional status measurements by the
 231 effective fertilization treatments was usually lower than the corresponding ones of the
 232 vegetative growth measurements. So, such trend could be logically explained as an
 233 expected dilution effect resulted by the relative higher accumulation rate of assimilated dry
 234 matter corresponding to the lower rate of increase in most nutrient elements. Moreover, the
 235 present results are in general accordance with those previously found by **Fawzia-Eissa,**
 236 **(2003)** on Canino apricot cv., **Kabeel et al., (2005)** on Canino apricot cv., **Stino et al.,**
 237 **(2009)** on Canino apricot cv., **Osman and Abd El-Rahman, (2010)** on Fig trees and
 238 **Darwish, (2012)** on Costata persimmon trees and **Baiea, et al., (2015)** on Banana cv.
 239 Grande Naine, **EL-Gioushy, (2016)** on young Manfalouty pomegranate trees and **Amin et**
 240 **al., (2017)** on pomegranate trees.
 241

242 **Table (3) No. of leaves/shoot, Leaf area (cm²) and Assimilation area (cm²) of young**
 243 **Wonderful pomegranate trees in response to NPK fertilization treatments with**
 244 **adopted common*, alternate natural-rocky mixture** and bio-NPK sources*** during**
 245 **2014 and 2015 season**
 246

NPK fertilization treatments (source and dose per trees)	Vegetative growth measurements during the two experimental seasons 2014 and 2015					
	No. of leaves/shoot		Leaf area (cm ²)		Assimilation area (cm ²)	
	2014	2015	2014	2015	2014	2015
T1- Adopted NPK fert. in region (control)	31.67 g	33.33 g	4.16 h	4.20 g	131.8 h	140.1 g
T2- 500g of alter. organo. Rocky mix. Only	28.67 h	30.67 h	4.12 h	4.14 h	118.3 i	127.1 h
T3- 1000g of alter. organo. Rocky mix. Only	36.33 f	39.33 f	4.30 g	4.40 f	156.4 g	173.2 f
T4- 1500g of alter. organo. Rocky mix. Only	40.00 d	43.00 e	4.77 e	4.78 d	190.8 e	205.6 d
T5- 2000g of alter. organo. Rocky mix. Only	47.33 c	48.00 d	4.97 d	5.01 c	235.5 d	240.6 c
T6- (T2 + 300 ml bio NPK mix.)	38.00 e	40.00 f	4.68 f	4.66 e	177.8 f	186.5 e
T7- (T3 + 300 ml bio NPK mix.)	49.67 b	49.33 c	5.07 c	5.01 c	252.1 c	247.2 c
T8- (T4 + 300 ml bio NPK mix.)	51.00 b	53.33 b	5.16 b	5.11 b	263.4 b	272.7 b
T9- (T5 + 300 ml bio NPK mix.)	58.67 a	59.00 a	5.27 a	5.28 a	309.2 a	311.8 a
T10- 300 ml bio NPK mixture only	31.33 g	31.67 h	4.17 h	4.14 h	130.6 h	131.3 h

247 *Means followed by the same letter/s within each column didn't significantly differ at 5% level*

248 **refers to the ordinary adopted NPK fertilizers after recommendation of Min. of Agric.*

249 ***refers to alternative NPK mixture (orange N and natural rocky PK materials at 1:1:1 by weight.*

250 ****refers to bio NPK fertilizers (Nitrobein, phosphorene and potassein) mix. at 1:1:1 by volume.*

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253

254 **Table (4) N %, P % and K % of young Wonderful pomegranate trees in response to**
 255 **NPK fertilization treatments with adopted common* alternate natural-rocky mixture****
 256 **and bio-NPK sources*** during 2014 and 2015 seasons**
 257

NPK fertilization treatments (source and dose per trees)	Vegetative growth measurements during the two experimental seasons 2014 and 2015							
	Total chlorophyll (mg/g F.W)		N (%)		P (%)		K (%)	
	2014	2015	2014	2015	2014	2015	2014	2015
T1- Adopted NPK fert. in region (control)	45.36 f	45.78 f	1.06 g	1.12 g	0.263 g	0.307 g	0.620 h	0.667 i
T2- 500g of alter. organo. Rocky mix. Only	44.32 g	43.80 g	1.03 h	1.10 h	0.250 g	0.287 h	0.597 i	0.710 h
T3- 1000g of alter. organo. Rocky mix. Only	46.94 e	48.03 e	1.26 f	1.28 f	0.340 f	0.353 f	0.787 g	0.813 g
T4- 1500g of alter. organo. Rocky mix. Only	48.68 d	49.52 d	1.33 e	1.37 d	0.420 d	0.420 e	0.957 e	0.980 e
T5- 2000g of alter. organo. Rocky mix. Only	49.74 c	51.34 c	1.43 c	1.50 b	0.467 c	0.480 d	0.977 d	1.020 d
T6- (T2 + 300 ml bio NPK mix.)	45.31 f	45.17 f	1.26 f	1.32 e	0.383 e	0.410 e	0.923 f	0.893 f
T7- (T3 + 300 ml bio NPK mix.)	49.08 cd	49.59 d	1.40 d	1.41 c	0.457 c	0.500 c	1.010 c	1.043 c
T8- (T4 + 300 ml bio NPK mix.)	51.73 b	52.98 b	1.45 b	1.51 ab	0.487 b	0.527 b	1.053 b	1.097 b

T9-(T5 + 300 ml bio NPK mix.)	53.88 a	54.18 a	1.50 a	1.53 a	0.530 a	0.547 a	1.087 a	1.127 a
T10- 300 ml bio NPK mixture only	43.70 g	43.78 g	1.03 h	1.06 i	0.247 g	0.287 h	0.603 hi	0.620 j

Means followed by the same letter/s within each column didn't significantly differ at 5% level

**refers to the ordinary adopted NPK fertilizers after recommendation of Min. of Agric.*

***refers to alternative NPK mixture (orange N and natural rocky PK materials at 1:1:1 by weight.*

****refers to bio NPK fertilizers (Nitrobein, phosphorene and potassein) mix. at 1:1:1 by volume.*

Table (5) Fe ppm, Mn ppm and Zn ppm of young Wonderful pomegranate trees in response to NPK fertilization treatments with adopted common* alternate natural-rocky mixture and bio-NPK sources*** during 2014and2015 seasons**

NPK fertilization treatments (source and dose per trees)	Vegetative growth measurements during the two experimental seasons 2014 and 2015					
	Fe (ppm)		Mn (ppm)		Zn (ppm)	
	2014	2015	2014	2015	2014	2015
T1- Adopted NPK fert. in region (control)	81.10 f	82.85 g	56.80 h	60.01 i	19.39 g	20.70 g
T2- 500g of alter. organo. Rocky mix. Only	80.83 f	80.96 i	60.73 g	63.52 h	19.00 g	19.12 h
T3- 1000g of alter. organo. Rocky mix. Only	89.07 e	87.19 f	62.57 f	65.28 g	21.78 e	22.98 e
T4- 1500g of alter. organo. Rocky mix. Only	97.14 c	95.92 d	68.15 e	68.78 e	24.82 c	25.47 c
T5- 2000g of alter. organo. Rocky mix. Only	98.32 c	99.36 c	71.21 d	72.87 d	26.23 b	27.60 b
T6- (T2 + 300 ml bio NPK mix.)	101.2 b	103.5 b	63.21 f	66.60 f	20.90 f	22.42 f
T7- (T3 + 300 ml bio NPK mix.)	94.31 d	93.39 e	72.69 c	74.37 c	23.43 d	24.72 d
T8- (T4 + 300 ml bio NPK mix.)	100.2 b	99.09 c	77.99 b	78.40 b	26.11 b	27.70 b
T9-(T5 + 300 ml bio NPK mix.)	103.3 a	106.2 a	80.36 a	81.66 a	29.28 a	31.42 a
T10- 300 ml bio NPK mixture only	80.56 f	82.02 h	54.51 i	55.08 j	17.79 h	18.11 i

Means followed by the same letter/s within each column didn't significantly differ at 5% level

**refers to the ordinary adopted NPK fertilizers after recommendation of Min. of Agric.*

***refers to alternative NPK mixture (orange N and natural rocky PK materials at 1:1:1 by weight.*

****refers to bio NPK fertilizers (Nitrobein, phosphorene and potassein) mix. at 1:1:1 by volume.*

4. CONCLUSION

It can be recommended from this present investigation that using mixture of organic N and rocky PK materials at either 1500 or 2000 g/tree combined with bio-NPK mixture at 300 ml/tree improved vegetative growth measurements (plant height, stem thickness, shoot length, No. of both shoots per tree and leaves per shoot, average leaf area and total assimilation area), as well as nutritional status (leaf chlorophyll, N, P, K, Fe, Mn and Zn contents) of young Wonderful pomegranate trees.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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