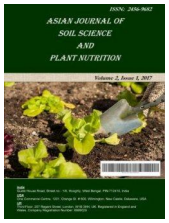

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Influence of Natural Alternative NPK and Bio-fertilizations on Vegetative Growth and Nutritional Status of Young Wonderful Pomegranate Trees

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Authors' contributions

This work was carried out in collaboration between all authors. Author MHMB designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors MAAGN and AA managed the analyses of the study. Author AA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To study the effects of natural alternative NPK and bio fertilizer on vegetative growth and nutritional status of Wonderful pomegranate trees.
Experimental Design: The complete randomized block design (RCBD) 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 in 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 were used at four doses (500, 1000, 1500 and 2000 g/tree) either solely or combined with bio NPK fertilizers and parameters of growth and nutritional status were evaluated.
Results: Obtained results declared that T_1 (control), T_2 (organo NPK rocky materials only at 500

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g/tree) and T_{10} (bio NPK fertilizers mixture solely at 300 ml/tree) seemed to be equally declined, followed in ascending order by T_3 (1000 g of alter. organo. Rocky mix. Only, T_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.), T4 (1500 g of alter. organo. Rocky mix. Only, T_5 (2000g of alter. organo. Rocky mix. Only), T_7 (Natural alternative NPK fertilizations mixture (organic N and PK raw mineral rocky materials) at 1000 g plus NPK bio-fertilizations mixture at 300 ml. per tree.) and T_8 (Natural alternative NPK fertilizations mixture (organic N and PK raw mineral rocky materials) at 1500 g plus NPK bio-fertilizations mixture at 300 ml. per tree.) and T_9 (Natural alternative NPK fertilizations mixture (organic N and PK raw mineral rocky materials) at 2000 g plus NPK bio-fertilizations mixture at 300 ml. per tree).

Conclusion: 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 (T_8 and T_9) improved vegetative growth measurements (plant height, stem thickness, shoot length, number of both shoots per tree and leaves per shoot, average leaf area and total assimilation area of plant), as well as nutritional status (leaf chlorophyll, N, P, K, Fe, Mn and Zn contents) of young Wonderful pomegranate trees.

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 are considered as a popular desirable rich sources for providing the local consumer with vitamin C, K, fibers and low-calories juice [1] and [2]. 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, [3].

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 vigorous and productive, leading the commercial variety in California. The pomegranate cultivar Wonderful is also known for its sweet taste, plentiful juice and health benefits that may help with heart disease, cancer and problems associated with aging. It is loaded with antioxidants, vitamins, potassium, folic acid and iron. This cultivar is widely-cultivated in California, while the last few years, it has replaced the native Greek cultivars. Now, Wonderful is the main pomegranate cultivar which is widely planted in Greece [4].

Building of a well strong tree canopy structure especially through the earlier orchard establishment stage i.e., juvenile phase of pomegranate trees is a real guaranty for realizing such aimed main factors closely related to increasing productivity and finally pomegranate grower's income could be realized certainly. Besides, decreasing cost of pomegranate production through using other NPK cheaper sources particularly those having availed option as being economical and environment friendly mineral or bio-fertilizer substances are the second reason by which the expected final goal could be achieved.

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

2. MATERIALS AND METHODS

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

The mechanical and chemical analyses of orchard soil were determined after the methods described by [5] and [6] as shown in Table 1.

The main goal was the possibility of replacing the major three expensive mineral concentrated NPK fertilizers with other cheaper and environment friendly natural NPK sources having either mineral, organic or bio nature. So, the ordinary common mineral NPK fertilization regime adopted in the region in the form of ammonium sulphate, superphosphate and potassium sulfate yearly added at the rate of 0.400, 0.400 and 0.200 Kg per tree, respectively were 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 P_2O_5 *, while 2nd as K fertilizer of 10-12 % actual K_2O* 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 facilitate 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.

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

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

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 (1:1:1 by 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 $(NH_4)_2SO_4$, superphosphate and K_2SO_4, 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.
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.
7. Natural alternative NPK fertilizations mixture (organic N and PK raw mineral rocky materials) at 1000 g plus NPK bio-fertilizations mixture at 300 ml. per tree.
8. Natural alternative NPK fertilizations mixture (organic N and PK raw mineral rocky materials) at 1500 g plus NPK bio-fertilizations mixture at 300 ml. per tree.
9. Natural alternative NPK fertilizations mixture (organic N and PK raw mineral rocky materials) at 1000 g plus NPK bio-fertilizations mixture at 300 ml. per tree.
10. NPK bio-fertilizations mixture solely at 300 ml. per tree.

All trees in this experiment were subjected to the same horticultural practices adopted in the farm concerning irrigation regime, micro-elements addenda weed and insect controlling.

Table 1. Physical and chemical properties of the experimental soil

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

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

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

2.1 Vegetative Growth

Plant height, trunk diameter at 10.0 cm above soil surface, average shoot length in cm., number of shoots/plant, leaves/shoot, area of individual leaf and total assimilation surface/shoot were determined. Whereas, average leaf area was estimated according to the following formula after [7]: Leaf area = 0.41(leaf length x its width) + 1.83.

2.2 Nutritional Status

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

2.2.1 Leaf total chlorophyll

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

2.2.2 Leaf total (N)

Leaf total (N) was determined by the modified micro Kjeldahl method mentioned by [8].

2.2.3 Leaf total P, K, Fe, Mn and Zn

Leaf total P, K, Fe, Mn and Zn were determined after [9].

2.3 Statistical Analysis

All data obtained during both seasons were subjected to analysis of variance according to [10] and significant differences among means were distinguishing according to the Duncan's multiple test range at P ≤0.05 [11].

3. RESULTS AND DISCUSSION

3.1 Vegetative Growth Measurements during 2014 and 2015 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, number of shoots/tree, number 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. It is quite clear to notice that the highest alternate-natural rocky mixture (2000 g) + 300 ml bio-NPK mixture (T_9) resulted significantly in the highest above-mentioned vegetative growth measurements during 2014 and 2015 experimental seasons. Moreover, T_8 (Natural alternative NPK fertilizations mixture (organic N and PK raw mineral rocky materials) at 1500 g plus NPK bio-fertilizations mixture at 300 ml. per tree) came statistically the 2nd for all vegetative growth measurements during both seasons. Anyhow, T_7 (1000 g alternate natural-rocky mixture + 300 ml bio-NPK mixture) ranked statistically the 3rd, decendingly, followed by T_6 (500 g alternate natural-rocky mixture + 300 ml bio-NPK mixture) and T_5 (2000 g alternate natural-rocky mixture) as both came the 4th during the two seasons for young Wonderful pomegranate trees.

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

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- 500 g 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- 1000 g 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- 1500 g 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- 2000 g 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- (500 g of alter. organo. Rocky mix.+ 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- (1000 g of alter. organo. Rocky mix. + 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- (1500 g of alter. organo. Rocky mix. + 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-(500 g of alter. organo. Rocky mix. + 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

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

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
T_1- Adopted NPK fert. in region (control)	31.67 g	33.33 g	4.16 h	4.20 g	131.8 h	140.1 g
T_2- 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
T_3- 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
T_4- 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
T_5- 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
T_6- (500g of alter. organo. Rocky mix.+ 300 ml bio NPK mix.)	38.00 e	40.00 f	4.68 f	4.66 e	177.8 f	186.5 e
T_7- (1000g of alter. organo. Rocky mix. + 300 ml bio NPK mix.)	49.67 b	49.33 c	5.07 c	5.01 c	252.1 c	247.2 c
T_8- (1500g of alter. organo. Rocky mix. + 300 ml bio NPK mix.)	51.00 b	53.33 b	5.16 b	5.11 b	263.4 b	272.7 b
T_9-(500g of alter. organo. Rocky mix. + 300 ml bio NPK mix.)	58.67 a	59.00 a	5.27 a	5.28 a	309.2 a	311.8 a
T_{10}- 300 ml bio NPK mixture only	31.33 g	31.67 h	4.17 h	4.14 h	130.6 h	131.3 h

*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*

On the contrary, the least significant increase in the above-mentioned vegetative growth measurements was also coupled to T_1 (Adopted NPK fertilizers in region or control), T_2 (500 g of alternate natural-rocky mixture) and T_{10} (300 ml of bio-NPK mixture) during 2014 and 2015 experimental seasons. In addition, T_3 (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 [12] on Canino apricot cv., [13] on Anna apple trees, [14] on Canino apricot cv., [15] on Fig trees, [16] on Costata persimmon trees, [17] on young Manfalouty pomegranate trees and [18] on pomegranate trees.

3.2 Nutritional Status Measurements during 2014 and 2015 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 2014 and 2015 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 (T_9) was statistically the superior,

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

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
T_1- 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
T_2- 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
T_3- 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
T_4- 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
T_5- 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
T_6- (500g of alter. organo. Rocky mix.+ 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
T_7- (1000g of alter. organo. Rocky mix. + 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
T_8- (1500g of alter. organo. Rocky mix. + 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
T_9-(500g of alter. organo. Rocky mix. + 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
T_{10}- 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 2014 and 2015 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
T_1- Adopted NPK fert. in region (control)	81.10 f	82.85 g	56.80 h	60.01 i	19.39 g	20.70 g
T_2- 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
T_3- 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
T_4- 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
T_5- 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
T_6- (500g of alter. organo. Rocky mix.+ 300 ml bio NPK mix.)	101.2 b	103.5 b	63.21 f	66.60 f	20.90 f	22.42 f
T_7- (1000g of alter. organo. Rocky mix. + 300 ml bio NPK mix.)	94.31 d	93.39 e	72.69 c	74.37 c	23.43 d	24.72 d
T_8- (1500g of alter. organo. Rocky mix. + 300 ml bio NPK mix.)	100.2 b	99.09 c	77.99 b	78.40 b	26.11 b	27.70 b
T_9-(500g of alter. organo. Rocky mix. + 300 ml bio NPK mix.)	103.3 a	106.2 a	80.36 a	81.66 a	29.28 a	31.42 a
T_{10}- 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*

while 300 ml of bio-NPK mixture only (T_{10}) was the inferior as shown the lowest values with all investigated measurements. Such trend was true during 2014 and 2015 experimental seasons. Moreover, T_8 (1500 g alternate natural-rocky mixture + 300 ml of bio-NPK mixture) ranked statistically the second, descendingly, followed by those of T_5 (2000 g alternate natural-rocky mixture), T_7 (1000 g alternate natural-rocky mixture + 300 ml bio-NPK mixture) and T_6 (500 g alternate natural-rocky mixture+ 300 ml of bio-NPK mixture). However, differences between T_1 (Adopted NPK fertilization in region) and T_2 (500 g alternate natural-rocky mixture) in most cases didn't reach the level of significance as compared with each other, regardless of young Wonderful pomegranate trees during both seasons. Such trend was true during the two seasons with very few exceptions.

On the other hand, the rate of increase in most nutritional status measurements by the effective fertilization treatments was usually lower than the corresponding ones of the vegetative growth measurements. So, such trend could be logically explained as an expected dilution effect resulted by the relative higher accumulation rate of assimilated dry matter corresponding to the lower rate of increase in most nutrient elements. Moreover, the present results are in general accordance with those previously found by [12] on Canino apricot cv., [14] on Canino apricot cv., [15] on Fig trees and [16] on Costata persimmon trees and [19] on Banana cv. Grande Naine, [17] on young Manfalouty pomegranate trees and [18] on pomegranate trees.

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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