Selecting The Best N, P and K Levels For The Newly Introduced Wounderful Pomegranate Trees Grown Under Minia Region

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Abstract: This study was initiated during 2013 & 2014 seasons to adjust the best N, P and K levels for Wounderful pomegranate trees grown under Minia region conditions. Nitrogen was applied at 100 to 400 g / tree/ year as well as both P and K were added at 50 to 100 g/ tree/ year. Increasing levels of N from 100 to 400 / tree was accompanied with enhancing all growth characters, N in the shoots and leaves, chlorophylls a & b, total chlorophylls, total carotenoids, number of flowers / shoot, fruit setting %, yield, fruit weight and dimensions, percentages of grain and juice, edible to non- edible portions, T.S.S. %, total and reducing sugars and anthocyanins in the juice and fruit peel. Shoot total carbohydrates %, C/N in the shoots, all nutrients (P,K, Mg, Ca, Zn, Fe, Mn), fruit peel weight and thickness, total acidity%, T.S.S./acid and total soluble tannins were gradually reduced with increasing N levels. A remarkable promotion was observed on all growth characters; shoot total carbohydrate %, C/N in the shoot, percentages of P, K and Mg, chlorophylls a & b, total chlorophylls, total carotenoids, fruit setting, yield and fruit quality with increasing both P & K levels from 50 to 100 g / tree/ Most nutrients and fruit peel weight and thickness, promace %, juice pH, total acidity % and total soluble tannins were declined with increasing levels of P & K. The best N, P and K levels for nutrition of Wounderful pomegranate grown under Minia region was the application of 300 g N + 100 g P_2O_5 + 100, K_2O / tree/ year.
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1. Introduction

Wounderful as a newly and promising pomegranate cv. grown successfully under Egypt conditions still needs a lot of studies towards adjusting the suitable horticultural practices that required for improving yield and fruit quality especially N, P and K fertilization. Several factors governed the N, P and K nutrition namely soil texture, climatic conditions, soil pH and fertility, water table depth, soil salinity, soil $CaCO_3$, irrigation system, variety, tree age, plant density, supporting and pruning systems, and climatic conditions. Fertilization with N, P and K is a backbone of plant nutrition. Building of all organic foods greatly depends on supplying the trees with their requirements from N, P and K at balanced rate (**Marschiner, 1995**).

Previous studies show that supplying pomegranate and other deciduous fruit crops with their needs from N, P and K at balanced rate was very necessary for improving yield and fruit quality (**Firak and Deolankar, 2000, Kabeel *et al.,* 2005; El-Sehrawy, 2008; Dhillon *et al.,* 2009; Von- Bennewtz *et al.,* 2011; Elkhawaga, 2011; Karimi *et al.,* 2012; Mansour *et al.,* 2013; Milosevic *et al.,* 2013; El-Sayed, 2013; Kumar and Ahmed, 2014 and Kaack and Pederson, 2014)**.

The merit of this study is adjusting the best levels of N, P and K fertilization that responsible for maximizing yield and improving fruit quality of Wounderful pomegranate trees grown under Minia region.

2. Material and Methods

This study was carried out during the two consecutive seasons of 2013 and 2014 on twenty – four uniform in vigour 5- years old Wounderful pomegranate trees (*Punicia granatum*, L.), grown in a private orchard situated at El- Hawarta Village, Minia district, Minia Governorate. The selected trees (24 trees) are planted in heavy clay soil (Table 1) at 4x 4 meters apart. Surface irrigation system using Nile water was adopted. The tested trees are subjected to regular horticultural practices that were commonly applied in the orchard including foliar application of micronutrients, hoeing, pruning and pest management. Soil analysis wad done according to the procedures that outlined by **Wilde *et al.* (1985)**.

This investigation included the following eight treatment from different N, P and K levels:

1- 100 g N + 50 g P_2O_5 + 50 g K_2O / tree / year.
2-100 g N + 100 g P_2O_5 + 50 g K_2O / tree / year.
3-200 g N + 50 g P_2O_5 + 50 g K_2O / tree / year.
4-200 g N + 100 g P_2O_5 + 100 g K_2O / tree / year.
5- 300 g N + 50 g P_2O_5 + 50 g K_2O / tree / year.
6- 300 g N + 100 g P_2O_5 + 100 g K_2O / tree / year.
7- 400 g N + 50 g P_2O_5 + 50 g K_2O / tree / year.
8- 400 g N + 100 g P_2O_5 + 100 g K_2O / tree / year.

Table (1): Analysis of the tested

Constituents	Values
Sand %	5.3
Silt %	14.7
Clay	80.0
Texture	Clay
pH (1: 2.5 extract)	7.8
EC (1: 2.5 extract) mmhos/ cm/ 25°C	0.94
O.M. %	2.60
CaCO3 %	1.64
Total	0.09
Available N (Olsen, ppm)	6.0
Available P (ppm)	5.0
Available K (ppm)	410

Each treatment was replicated three times, one tree per each. The assigned amounts of ammonium nitrate (33.5 % N) as a source of N fertilizer equal 100, 200, 300 and 400 g N are 300, 600, 900 and 1200 g ammonium nitrate per tree, respectively. The amounts of potassium sulphate (48% K_2O) equal 50 and 100 g K_2O/ tree are 105 and 210 g / tree, respectively. The amounts of mono-calcium superphosphate (15.5 % P_2O_5) equal 50 and 100 g P_2O_5/ tree are 325 and 650 g respectively. Ammonium nitrate (33.5 %N) was divided into three equal batches and applied at the first week of March, May and July during both seasons. Both potassium sulphate and mono-calcium superphosphate were splitted into two equal batches and applied at the first week of March and May. All N, P and K fertilizers were broadcasted under tree canopy about 25 cm far from trunk.

The experiment was arranged in a randomized complete block design (RCBD) with eight treatments, each was replicated three times, one tree per each.

During both seasons, the following measurements were recorded:

1- Some vegetative growth aspects namely number of new shoots/ tree, length & diameter of shoot, leaf area (cm^2) (**Mofeed, 2009**) and total surface area/ plant.
2- Leaf and shoot chemical composition parameters namely shoot N % (**Wilde *et al.*, 1985**), shoot total carbohydrates % (**Smith *et al.*, 1956**), C/N in the shoot, leaf N, P, K, Mg and Ca (%) and Zn, Fe and Mn (ppm) (**Raghupathi and Bahragava, 1998 and Klara, 1998**); chlorophylls a & b, total chlorophylls and total carotenoids as mg/ g. F.W. (**Fadl and Sari El- Deen, 1978**).
3- Flowering, fruit setting % and yield parameters namely number of flowers per shoot, percentages of initial fruit setting and fruit retention, number of fruits / tree and yield (kg.)
4- Some physical and chemical characteristics of the fruits namely fruit weight (g.) and dimensions (height & diameter in cm), fruit shape, fruit peel weight % and peel thickness (cm.), percentages of juice, grains and pomace, edible to non – edible portions, T.S.S.%, total and reducing sugars % (**A.O.A.C., 2000**); total acidity % (**A.O.A.C., 2000**) as citric acid, T.S.S./acid, juice pH, total soluble tannins (**Balbaa, 1981**) and total anthocyanins (**Fulcki and Francis, 1968**).

Statistica analysis was carried out using new L.S.D. at 5% (**Snedecor and Cochran, 1990**).

3. Results

1- Vegetative growth characters:

Data in Tables (2 &3) show that increasing levels of N from 200 to 400 g / tree as well as both P & K from 50 to 100 g / tree caused a gradual stimulation on the number of new shoots / tree, length and width of shoot, leaf area and total surface area. Meaningless stimulation on such growth characters was observed among the higher two levels of N (300 & 400 g / tree) and both P and K levels (50 & 100 g / tree). The maximum values were recorded on the trees that fertilized with 400 g N+ 100 g P_2O_5 + 100 g K_2O / tree. These results were true during both seasons.

2- Shoot and leaf chemical composition.

It is clear from the data in Tables (3 & 4 & 5) that increasing level of N had significant promotion on shoot N % and leaf N %. A significant reduction on shoot total carbohydrates %, C/N in the shoots, percentages of P & K & Mg and Ca as well as Zn, Fe and Mn in the leaves was observed due to increasing levels of N. All nutrients except N in the shoots and leaves as well as leaf content of Ca, Zn, Fe and Mn were increased with increasing both P & K levels. In most cases, increasing N levels from 300 to 400 g / tree had negligible stimulation. Also, a slight promotion was attributed due to increasing both P & K levels from 50 to 100 g / tree.

3- Plant pigments:

It is evident from the data in Table (6) that increasing levels of N from 100 to 400 g / tree as well as both P & K from 50 to 100 g / tree caused a gradual and significant promotion on chlorophylls a & b, total chlorophylls and total contents. The maximum values were recorded on the tree that fertilized with 400 g N + 100 g P_2O_5 + 1000 g K_2O / tree. Using 100 g N + 50 g P_2O_5 + 50 K_2O/ tree gave the lowest values. Similar results were announced during both seasons.

4- Flowering, fruit setting % and yield/ tree:

Data listed in Tables (7, 8) clearly show that number of flowers / shoot, percentages of initial fruit setting and fruit retention, number of fruits/tree and yield /tree were significantly increased gradually with

increasing levels of N from 100 to 400 g / tree and both P & K from 50 to 100 g / tree. Significant differences on all parameters were observed between all N levels except the higher two levels (300 & 400 g / tree). Increasing both P & K levels failed significantly to promote this investigated parameters. From economical point of view, supplying Wounderful pomegranate trees with 300 g N + 100 g P_2O_5 + 100 g K_2O was considered the best N, P and K treatment. Under such promised treatment, yield per tree reached 49.8 and 53.9 kg during both seasons, respectively. The lowest levels of N (100 g), P (50 g) and K (50 g) per tree produced 18.1 and 21.5 kg fruits during both seasons, respectively. The same trend was noticed during both seasons.

5- Fruit quality:

It is worth to mention from the data in Tables (8 to 12) that increasing levels of N from 100 to 300 g / tree as well as both P & K from 50 to 100 g / tree caused a progressive promotion on fruit quality expressed in increasing fruit weight and dimensions, percentages of grains and juice, edible to none edible portions, T.S.S. %, reducing and total sugars and total anthocyanins in the peels and juice and reducing fruit peel weight % and thickness, percentage of pomace, total acidity %, juice pH, total soluble tannins and T.S.S. / acid. Values of T.S.S. /acid were increased slightly with increasing both P & K levels from 50 to 100 g / tree. Using levels of N above 300 g / tree namely 400 g / tree caused significant adverse effects on fruit quality. The best fruit quality was observed on the trees that fertilized with 300 g N + 100 g P_2O_5 + 100 K_2O / tree. Unfavourable effects on fruit quality was attributed to using the lower levels of N, P and K namely 100 g N + 50 g P_2O_5 + 50 K_2O / tree. These results were true during both seasons.

Table (2): Effect of various levels of N, P and K fertilizers on some vegetative growth characters of Wounderful pomegranate trees during 2013 & 2014 seasons.

N, P and K fertilization treatments	No. of new shoots / tree		Shoot length (mm)		Shoot diameter (mm)		Leaf area ($cm)^2$	
	2013	2014	2013	2014	2013	2014	2013	2014
100 g N + 50 g P_2O_5 + 50 g K_2O / tree	93.7	95.0	95.3	97.0	7.1	6.9	9.4	9.7
100 g N + 100 g P_2O_5 + 100 g K_2O / tree	94.2	95.8	96.0	97.3	7.2	7.0	9.5	9.9
200 g N + 50 g P_2O_5 + 50 g K_2O / tree	97.2	98.9	99.8	103.3	7.5	7.4	10.1	11.1
200 g N + 100 g P_2O_5 + 100 g K_2O / tree	98.0	99.3	101.0	104.0	7.6	7.5	10.3	11.5
300 g N + 50 g P_2O_5 + 50 g K_2O / tree	106.9	108.9	106.3	108.9	8.0	7.8	11.9	13.5
300 g N + 100 g P_2O_5 + 100 g K_2O / tree	107.3	109.3	107.0	109.3	8.1	7.9	12.0	13.6
400 g N + 50 g P_2O_5 + 50 g K_2O / tree	107.0	109.0	107.3	109.3	8.1	7.9	12.1	13.7
400 g N + 100 g P_2O_5 + 100 g K_2O / tree	108.0	110.0	107.7	109.7	8.2	8.0	12.3	13.8
New L.S.D. at 5%	1.9	2.0	1.7	1.8	0.2	0.2	0.4	0.4

N = Ammonium nitrate form (33.5% N), P= Mono-Calcium superphosphate (15.5 % P_2O_5) and K = Potassium sulphate (48% K_2O)

Table (3): Effect of various levels of N, P and K fertilizers on total surface area per tree, percentages of N and total carbohydrates and the ratio between N and total carbohydrates in the shoots of Wounderful pomegranate trees during 2013 & 2014 seasons.

N, P and K fertilization treatments	Total surface area / tree (m^2)		Shoot N %		Shoot total carbohydrates %		C/N in the shoots	
	2013	2014	2013	2014	2013	2014	2013	2014
100 g N + 50 g P_2O_5 + 50 g K_2O / tree	4.40	4.61	0.74	0.76	8.9	9.1	12.02	11.97
100 g N + 100 g P_2O_5 + 100 g K_2O / tree	4.47	4.74	0.70	0.71	9.4	9.7	13.43	13.66
200 g N + 50 g P_2O_5 + 50 g K_2O / tree	4.91	5.49	0.82	0.86	8.4	8.7	10.24	10.12
200 g N + 100 g P_2O_5 + 100 g K_2O / tree	5.05	5.71	0.77	0.81	8.9	9.2	11.56	11.36
300 g N + 50 g P_2O_5 + 50 g K_2O / tree	6.36	7.35	0.93	0.92	8.0	8.3	8.60	9.02
300 g N + 100 g P_2O_5 + 100 g K_2O / tree	6.44	7.43	0.87	0.86	8.4	8.7	9.66	10.12
400 g N + 50 g P_2O_5 + 50 g K_2O / tree	6.47	7.47	1.01	0.99	7.1	7.3	7.03	7.37
400 g N + 100 g P_2O_5 + 100 g K_2O / tree	6.64	7.59	0.94	0.91	6.7	7.0	7.13	7.69
New L.S.D. at 5%	0.19	0.22	0.05	0.04	0.3	0.3	0.09	0.11

N = Ammonium nitrate form (33.5% N), P= Mono-Calcium superphosphate (15.5 % P_2O_5) and K = Potassium sulphate (48% K_2O)

Table (4): Effect of various levels of N, P and K fertilizers on the percentages of N, P, K and Mg in the leaves of Wounderful pomegranate trees during 2013 & 2014 seasons.

N, P and K fertilization treatments	Leaf N %		Leaf P %		Leaf K %		Leaf Mg %	
	2013	2014	2013	2014	2013	2014	2013	2014
100 g N + 50 g P_2O_5 + 50 g K_2O / tree	1.61	1.70	0.33	0.35	1.32	1.36	0.65	0.70
100 g N + 100 g P_2O_5 + 100 g K_2O / tree	1.51	1.60	0.37	0.40	137	1.41	0.70	0.74
200 g N + 50 g P_2O_5 + 50 g K_2O / tree	1.72	1.81	0.29	0.31	1.27	1.30	0.60	0.65
200 g N + 100 g P_2O_5 + 100 g K_2O / tree	1.63	1.072	0.33	0.35	1.32	1.35	0.65	0.67
300 g N + 50 g P_2O_5 + 50 g K_2O / tree	1.84	1.93	0.25	0.27	1.22	1.24	0.55	0.56
300 g N + 100 g P_2O_5 + 100 g K_2O / tree	1.76	1.85	0.29	0.30	1.27	1.29	0.59	0.61
400 g N + 50 g P_2O_5 + 50 g K_2O / tree	1.95	2.04	0.20	0.22	1.17	1.19	0.48	0.50
400 g N + 100 g P_2O_5 + 100 g K_2O / tree	1.86	1.95	0.25	0.25	1.21	1.24	0.53	0.55
New L.S.D. at 5%	0.07	0.06	0.03	0.03	0.04	0.04	0.04	0.04

N = Ammonium nitrate form (33.5% N), P= Mono-Calcium superphosphate (15.5 % P_2O_5) and K = Potassium sulphate (48% K_2O)

Table (5): Effect of various levels of N, P and K fertilizers on the percentage of Ca as well as Zn, Fe and Mn (as ppm) on the leaves of Wounderful pomegranate trees during 2013 & 2014 seasons.

N, P and K fertilization treatments	Leaf Ca %		Leaf Zn (ppm)		Leaf Fe (ppm)		Leaf Mn (ppm)	
	2013	2014	2013	2014	2013	2014	2013	2014
100 g N + 50 g P_2O_5 + 50 g K_2O / tree	3.11	3.20	55.1	57.3	57.0	59.2	52.0	54.2
100 g N + 100 g P_2O_5 + 100 g K_2O / tree	2.99	3.08	51.0	54.0	52.9	55.8	47.8	50.8
200 g N + 50 g P_2O_5 + 50 g K_2O / tree	3.00	3.09	51.6	52.0	53.5	53.9	48.5	48.3
200 g N + 100 g P_2O_5 + 100 g K_2O / tree	2.81	2.90	49.0	49.1	50.9	51.1	46.0	46.1
300 g N + 50 g P_2O_5 + 50 g K_2O / tree	2.81	2.90	48.2	47.0	51.2	48.9	46.1	44.1
300 g N + 100 g P_2O_5 + 100 g K_2O / tree	2.71	2.80	46.0	44.0	47.8	45.9	42.9	41.6
400 g N + 50 g P_2O_5 + 50 g K_2O / tree	2.51	2.60	45.0	43.0	46.9	44.8	41.9	39.0
400 g N + 100 g P_2O_5 + 100 g K_2O / tree	2.41	2.50	42.2	42.0	44.1	43.9	39.1	37.0
New L.S.D. at 5%	0.07	0.08	2.1	2.0	1.9	1.8	1.5	1.6

N = Ammonium nitrate form (33.5% N), P= Mono-Calcium superphosphate (15.5 % P_2O_5) and K = Potassium sulphate (48% K_2O)

Table (6): Effect of various levels of N, P and K fertilizers on some plant pigments in the leaves of Wounderful pomegranate trees during 2013 & 2014 seasons.

N, P and K fertilization treatments	Chlorophyll a (mg/ 1.0 g F.W.)		Chlorophyll b (mg/ 1.0 g F.W.)		Total chlorophylls (mg/ 1.0 g F.W.)		Total carotenoids (mg/ 1.0 g F.W.)	
	2013	2014	2013	2014	2013	2014	2013	2014
100 g N + 50 g P_2O_5 + 50 g K_2O / tree	5.11	5.20	2.17	2.30	7.28	7.50	2.02	2.15
100 g N + 100 g P_2O_5 + 100 g K_2O / tree	5.51	5.60	2.33	2.46	7.84	8.06	2.18	2.31
200 g N + 50 g P_2O_5 + 50 g K_2O / tree	5.91	6.01	2.50	2.63	8.41	8.64	2.35	2.48
200 g N + 100 g P_2O_5 + 100 g K_2O / tree	6.41	6.51	2.70	2.84	9.11	9.35	2.54	2.70
300 g N + 50 g P_2O_5 + 50 g K_2O / tree	7.11	7.20	2.79	2.92	9.90	10.12	2.63	2.77
300 g N + 100 g P_2O_5 + 100 g K_2O / tree	7.50	7.60	3.00	3.13	10.50	10.73	2.85	2.97
400 g N + 50 g P_2O_5 + 50 g K_2O / tree	7.43	7.50	3.20	3.33	10.63	10.83	3.05	3.18
400 g N + 100 g P_2O_5 + 100 g K_2O / tree	7.82	7.84	3.35	3.50	11.17	11.34	3.19	3.35
New L.S.D. at 5%	0.21	0.22	0.14	0.13	0.21	0.22	0.14	0.17

N = Ammonium nitrate form (33.5% N), P= Mono-Calcium superphosphate (15.5 % P_2O_5) and K = Potassium sulphate (48% K_2O)

Table (7): Effect of various levels of N, P and K fertilizers on the number of flowers/ shoot, percentages of initial fruit setting and fruit retention and number of fruits per tree of Wounderful pomegranate trees during 2013 & 2014 seasons.

N, P and K fertilization treatments	No. of flowers / shoot		Initial fruit setting %		Fruit retention %		No. of fruits / tree	
	2013	2014	2013	2014	2013	2014	2013	2014
100 g N + 50 g P_2O_5 + 50 g K_2O / tree	2.0	2.0	40.0	41.7	26.0	26.9	51.6	59.3
100 g N + 100 g P_2O_5 + 100 g K_2O / tree	2.0	2.0	40.7	42.4	26.3	27.2	53.7	61.0
200 g N + 50 g P_2O_5 + 50 g K_2O / tree	3.0	3.0	43.3	45.0	28.0	28.8	68.7	71.7
200 g N + 100 g P_2O_5 + 100 g K_2O / tree	3.0	3.0	44.0	45.6	28.4	29.3	71.0	72.6
300 g N + 50 g P_2O_5 + 50 g K_2O / tree	4.0	4.0	48.9	50.6	3.00	30.8	96.7	103.0
300 g N + 100 g P_2O_5 + 100 g K_2O / tree	4.0	4.0	49.1	51.0	30.5	31.4	98.6	104.0
400 g N + 50 g P_2O_5 + 50 g K_2O / tree	4.0	4.0	49.0	51.0	30.2	31.0	99.0	104.0
400 g N + 100 g P_2O_5 + 100 g K_2O / tree	4.0	4.0	49.3	51.3	30.8	31.6	100.0	105.0
New L.S.D. at 5%	1.0	1.0	1.0	1.0	0.9	0.9	4.0	3.5

N = Ammonium nitrate form (33.5% N), P= Mono-Calcium superphosphate (15.5 % P_2O_5) and K = Potassium sulphate (48% K_2O)

Table (8): Effect of various levels of N, P and K fertilizers on the yield / tree as well as fruit weight and dimensions (height & diameter) of Wounderful pomegranate trees during 2013 & 2014 seasons.

N, P and K fertilization treatments	Yield / tree (kg.)		Fruit weight (g.)		Fruit height (cm.)		Fruit diameter (cm.)	
	2013	2014	2013	2014	2013	2014	2013	2014
100 g N + 50 g P_2O_5 + 50 g K_2O / tree	18.1	21.5	350.9	361.9	7.20	7.27	7.91	7.98
100 g N + 100 g P_2O_5 + 100 g K_2O / tree	19.4	22.7	361.0	372.0	7.31	7.38	8.00	8.07
200 g N + 50 g P_2O_5 + 50 g K_2O / tree	27.5	29.6	401.0	412.7	8.66	8.73	9.33	9.40
200 g N + 100 g P_2O_5 + 100 g K_2O / tree	28.8	30.3	405.0	417.0	8.71	8.78	9.40	9.47
300 g N + 50 g P_2O_5 + 50 g K_2O / tree	48.4	52.6	500.0	511.0	8.21	9.30	10.00	10.08
300 g N + 100 g P_2O_5 + 100 g K_2O / tree	49.8	53.9	505.0	518.0	9.25	9.32	10.09	10.18
400 g N + 50 g P_2O_5 + 50 g K_2O / tree	49.8	53.2	502.7	512.0	9.25	9.32	10.09	10.11
400 g N + 100 g P_2O_5 + 100 g K_2O / tree	50.8	54.7	507.7	521.0	9.28	9.36	10.12	10.25
New L.S.D. at 5%	1.6	1.7	15.0	16.1	0.18	0.20	0.19	0.19

N = Ammonium nitrate form (33.5% N), P= Mono-Calcium superphosphate (15.5 % P_2O_5) and K = Potassium sulphate (48% K_2O)

Table (9): Effect of various levels of N, P and K fertilizers on some physical characters of the fruits of Wounderful pomegranate trees during 2013 & 2014 seasons.

N, P and K fertilization treatments	Fruit shape		Fruit peel weight %		Fruit peel thickness (cm.)		Grain %	
	2013	2014	2013	2014	2013	2014	2013	2014
100 g N + 50 g P_2O_5 + 50 g K_2O / tree	1.10	1.10	48.2	49.0	0.22	0.26	51.8	51.0
100 g N + 100 g P_2O_5 + 100 g K_2O / tree	1.09	1.09	48.0	48.7	0.18	0.22	52.0	51.3
200 g N + 50 g P_2O_5 + 50 g K_2O / tree	1.08	1.08	46.0	46.7	0.27	0.31	54.0	53.3
200 g N + 100 g P_2O_5 + 100 g K_2O / tree	1.08	1.08	45.7	46.3	0.23	0.27	54.3	53.7
300 g N + 50 g P_2O_5 + 50 g K_2O / tree	1.09	1.08	45.0	45.0	0.37	0.41	55.0	55.0
300 g N + 100 g P_2O_5 + 100 g K_2O / tree	1.09	1.09	44.7	44.5	0.32	0.36	55.3	55.5
400 g N + 50 g P_2O_5 + 50 g K_2O / tree	1.09	1.08	44.5	45.0	0.38	0.43	55.5	55.0
400 g N + 100 g P_2O_5 + 100 g K_2O / tree	1.09	1.10	44.3	44.4	0.31	0.35	55.7	55.6
New L.S.D. at 5%	NS	NS	0.8	0.9	0.03	0.03	1.0	1.1

N = Ammonium nitrate form (33.5% N), P= Mono-Calcium superphosphate (15.5 % P_2O_5) and K = Potassium sulphate (48% K_2O)

Table (10): Effect of various levels of N, P and K fertilizers on some physical and chemical characteristics of the fruits of Wounderful pomegranate trees during 2013 & 2014 seasons.

N, P and K fertilization treatments	Juice %		Pomace %		Edible / nonedible portions		T.S.S. %	
	2013	2014	2013	2014	2013	2014	2013	2014
100 g N + 50 g P_2O_5 + 50 g K_2O / tree	35.1	36.0	16.7	15.0	1.07	1.04	11.9	12.1
100 g N + 100 g P_2O_5 + 100 g K_2O / tree	35.5	36.5	16.5	14.8	1.08	1.05	12.1	12.2
200 g N + 50 g P_2O_5 + 50 g K_2O / tree	38.9	39.8	15.1	13.5	1.17	1.14	12.4	12.5
200 g N + 100 g P_2O_5 + 100 g K_2O / tree	39.1	40.1	15.2	13.6	1.19	1.15	12.5	12.6
300 g N + 50 g P_2O_5 + 50 g K_2O / tree	42.9	44.0	12.1	11.0	1.22	1.22	12.8	13.9
300 g N + 100 g P_2O_5 + 100 g K_2O / tree	43.0	44.3	12.3	11.2	1.24	1.25	12.9	14.0
400 g N + 50 g P_2O_5 + 50 g K_2O / tree	43.0	44.4	12.5	10.6	1.25	1.22	12.0	13.0
400 g N + 100 g P_2O_5 + 100 g K_2O / tree	43.3	44.5	12.4	11.1	1.26	1.25	12.1	13.2
New L.S.D. at 5%	1.0	0.9	0.8	0.7	0.02	0.02	0.3	0.3

N = Ammonium nitrate form (33.5% N), P= Mono-Calcium superphosphate (15.5 % P_2O_5) and K = Potassium sulphate (48% K_2O)

Table (11): Effect of various levels of N, P and K fertilizers on some chemical characteristics of the fruits of Wounderful pomegranate trees during 2013 & 2014 seasons.

N, P and K fertilization treatments	Total acidity %		T.S.S./ acid		Juice pH		Total sugars %	
	2013	2014	2013	2014	2013	2014	2013	2014
100 g N + 50 g P_2O_5 + 50 g K_2O / tree	2.210	2.217	5.4	5.5	2.55	2.66	10.5	10.9
100 g N + 100 g P_2O_5 + 100 g K_2O / tree	2.191	2.198	5.5	5.6	2.54	2.65	10.6	11.0
200 g N + 50 g P_2O_5 + 50 g K_2O / tree	2.391	2.398	5.2	5.2	2.66	2.77	10.9	11.5
200 g N + 100 g P_2O_5 + 100 g K_2O / tree	2.382	2.390	5.2	5.3	2.65	2.75	11.0	11.6
300 g N + 50 g P_2O_5 + 50 g K_2O / tree	3.111	3.118	4.1	4.5	2.85	2.96	11.5	12.1
300 g N + 100 g P_2O_5 + 100 g K_2O / tree	3.106	3.113	4.2	4.5	2.84	2.95	11.6	12.2
400 g N + 50 g P_2O_5 + 50 g K_2O / tree	3.115	3.122	3.9	4.2	2.87	2.97	11.0	11.7
400 g N + 100 g P_2O_5 + 100 g K_2O / tree	3.110	3.117	3.9	4.2	2.83	2.96	1.11	11.8
New L.S.D. at 5%	0.027	0.031	0.3	0.3	0.05	0.06	0.3	0.3

N = Ammonium nitrate form (33.5% N), P= Mono-Calcium superphosphate (15.5 % P_2O_5) and K = Potassium sulphate (48% K_2O)

Table (12): Effect of various levels of N, P and K fertilizers on some chemical characteristics of the fruits of Wounderful pomegranate trees during 2013 & 2014 seasons.

N, P and K fertilization treatments	Reducing sugars %		Total soluble tannins %		Juice total anthocyanins (mg/ 100 g F.W.)		Peel total anthocyanins (mg/ 100 g F.W.)	
	2013	2014	2013	2014	2013	2014	2013	2014
100 g N + 50 g P_2O_5 + 50 g K_2O / tree	9.1	9.2	1.00	1.05	51.0	51.9	94.2	95.0
100 g N + 100 g P_2O_5 + 100 g K_2O / tree	9.3	9.4	0.98	1.03	51.5	52.5	95.0	96.0
200 g N + 50 g P_2O_5 + 50 g K_2O / tree	9.9	10.0	0.82	0.87	53.0	54.1	97.6	98.5
200 g N + 100 g P_2O_5 + 100 g K_2O / tree	10.0	10.2	0.81	0.86	53.3	54.3	98.0	98.0
300 g N + 50 g P_2O_5 + 50 g K_2O / tree	10.5	10.7	0.60	0.64	59.9	60.0	101.0	102.0
300 g N + 100 g P_2O_5 + 100 g K_2O / tree	10.6	10.8	0.59	0.64	60.0	60.4	101.6	102.4
400 g N + 50 g P_2O_5 + 50 g K_2O / tree	8.7	8.5	0.69	0.71	51.0	51.9	101.9	102.0
400 g N + 100 g P_2O_5 + 100 g K_2O / tree	8.9	8.6	0.67	0.70	51.3	52.0	102.0	102.6
New L.S.D. at 5%	0.3	0.3	0.03	0.03	0.9	1.0	1.0	1.1

N = Ammonium nitrate form (33.5% N), P= Mono-Calcium superphosphate (15.5 % P_2O_5) and K = Potassium sulphate (48% K_2O)

4. Discussion

The obtained data could be discussed as follows:

1- The importance of N in the biosynthesis of proteins, enzymes, organic foods, plant pigments, vitamins, hormones as well as building cell walls, middle lamella and enhancing division (**Mengel *et al.*, 2001**).

2- The beneficial effects of K on enhancing the activity of most enzymes, root development, drought resistance, formation of proteins and total sugars. It is responsible for enhancing the resistance of plants to disease and salinity, self-life, water retention, photosynthesis, nutrient and water uptake. It is also regulated the opening and closure of stomata and enhancing cell division and ethylene production (**Yagodin, 1990**).

3- The positive action of P on growth and fruiting of Wounderful pomegranate might be attributed to its effect in enhancing the biosynthesis of sugars. DNA, RNA, ATP, APP, the activation of several enzymes, cell division, plant pigments, and uptake of some nutrients (**Mengel *et al.*, 2001**).

4- Using N, P and K at balancing rate was favourable in enhancing flowering and fruit setting behaviour of the trees at the expense of vegetative growth characters. The ratio between total carbohydrate and N was beneficially adjusted when the N, P and K fertilizers were added via balanced rate. Under such conditions the number of flowers was greatly formed. Most nutrients were reduced due to using N, P and K. this is due to their exhaustion or depletion on forming growth and fruiting portions.

The beneficial effect of N, P and K especially when applied at balanced rate on growth, and fruiting of Wounderful pomegranate trees are in harmony with those obtained by **Firak and Deolanker (2000), Li (2000), Dhillon *et al.*, (2009) and El- Sayed (2013)** on different pomegranate cvs. The same trend was observed in another deciduous fruit crops by **El-khawaga (2011), Von- Bennewitz *et al.*, (2011); Milosevic *et al.*, (2013) and Kumar- and Ahmed (2014)**.

Conclusion:

It is advised to fertilize Wouderful pomegranate trees grown under Minia region with 300 g N + 100 g P_2O + 100 g K_2O / tree for promoting productivity of the trees.

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