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Influence of Different Soil Applied Levels of (NPK) and Compost on Growth, Yield, Fruit Quality and Leaf Nutrient Content, of "Anna" Apple Cultivar Trees

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ABSTRACT

The current study was undertaken to evaluate the effects of various soil applied rates of (NPK) and compost compound either alone or in combination on some vegetative growth measurements, fruiting aspects, fruit quality and leaf nutritional status of "Anna" apple cultivar trees budded on MM106 rootstock grown at El-Kanater Experimental farm belonging to Horticultural Research Station during the two successive seasons of 2011 and 2012. Data obtained clearly indicated that, most of the (NPK) and (compost) levels either alone or in combination treatments exhibited a positive effect and a significant increment in all studied vegetative growth parameters i.e., shoot length, number of leaves per shoot and leaf surface area. Moreover, fruiting parameters (yield as kg/tree and ton per fed.) were statistically increased with increasing the levels of the most studied treatments in the two seasons of experimental study. Also, data revealed obviously that, fruit characteristics including both fruit physical properties i.e., (fruit weight, volume, firmness, length and diameter) and fruit chemical characteristics such as TSS %, total acidity % and TSS/acid ratio were significantly improved when treated trees with various treatments especially with the highest soil applied levels of NPK or/and compost when compared to the lowest level. Furthermore, leaf nutritional status of some studied nutrients i.e., nitrogen, phosphorus and potassium were generally improved and increased as a result of the different investigated treatments under this investigation from the standpoint of statistic during both seasons of study. Generally, it could be concluded that, most of (NPK) and (compost) soil applied treatments either alone or in combination resulted in a positive and a significant effect on all investigated vegetative growth, fruiting aspects and both fruit quality (properties) and leaf nutrient content of "Anna" apple trees in most cases. Furthermore, the highest level of combination treatment of ($N_4P_4K_4$ + compost at 2000 ml^3) was the most effective treatment for increasing growth, yield, leaf nutrient contents and improving the most fruit properties.

INTRODUCTION

In Egypt apple fruit trees is considered one of the most important deciduous fruits. There are several problems facing fruit trees growers which affect on the productivity and fruit quality of apple trees. Large amounts and high costs of mineral fertilizers needed to fruit trees are the reasons of these problems. In addition to that, using of mineral fertilizer at high quantities has an increment role in the health problems of mankind. However, it is considered one of the very important factors for air, soil and water polluting agent results from leaching of an excessive into the soil led to disturbance in the natural biological balance in the soil and which may accumulates in feed chain casing hazardous effects to human health. Thus, the vital and important aims of many investigators resorted to new attitude by using organic compounds to reducing both production costs and also environmental pollution.

Therefore, a great attention is focused on the soil applied of mineral fertilizers combined with organic compounds through many studies and several attempts in order to reduce of N, P and K mineral fertilizers partially. For that, many investigations and attempts were conducted in this respect by some researchers, Mekhael (1994), Awasthi *et al*., (1997) and Kabeel *et al*., (2007) on apple; Nassef (2000) and Kabeel and El-Saadany (2004) on pear; Kabeel (2004) on peach; Bussi *et al*., (2003), Kabeel *et al*., (2005), Shddad *et al*., (2005) and Kandil and Ahmed (2010) on apricot and Abou Grah-Fatma (2004), Wahba (2007), Darwesh (2012) and Sharaf *et al*., (2012) on persimmon trees.

Accordingly, the present investigation was planned and carried out to evaluate the influence rates of the different rates of (NPK) mineral and organic fertilizers either alone or combined, to evaluate the best and optimal (NPK) and/or organic soil applied level and consequently the most effective treatments on some vegetative growth, fruiting aspects, fruit characteristics and leaf nutritional status of "Anna" apple cultivar trees during the course of this study.

MATERIALS AND METHODS

This study was conducted through 2011 and 2012 seasons on 8-year-old "Anna" cultivar apple trees budded on MM106 rootstock, planted at 4 x 5 meters apart grown on a clay loamy soil and surface irrigation system was used at the experimental Farm of El-Kanater Horticultural Research Station, Kalyubia Governorate, Egypt.

Thirty six trees of almost similar as possible in growth vigour were devoted for this study whereas, the experimental treatments were arranged in a complete randomized block deign with three replicates for each treatment and each replicate was represented by a single tree.

Physical and chemical analysis of the experimental soil samples at (0-60 cm) depth was carried out according to the standard methods that described by Piper (1950) and their data presented in Table (1).

Table 1. Physical and chemical analysis of orchard soil at (0-60 cm) depth before starting the experiment in 2011 season.

Character	(A) Physical analysis				(B) Chemical analysis				
	Sand (%)	**Silt (%)**	**Clay (%)**	**Soil texture**	**E.C. ds/m**	**pH (1:25)**	**$CaCO_3$**	**Organic matter (%)**	**Total (N) ppm**
	19.60	25.58	53.96	Clay loamy	1.28	7.79	2.76	1.08	378.40
Character	Soluble cations meq/100 gm soil				Soluble Anions				
	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Cl^{-}	HCO_3^{-}	CO_3^{-}	SO_4^{--}	
	3.32	1.87	4.03	0.90	3.98	4.15	-	1.68	

The commercial name of the organic manure (compost) used in this experiment was "Biobinta", and its physical and chemical analysis is shown in Table (2).

Table 2. Chemical and physical analysis of compost Biobinta.

Character (nutrient element)	Content	Character	Values
Total N %	1.46	pH (1 : 10)	6.53
Total P %	0.59	EC (dS/m)	3.37
Total K %	1.35	Organic matter	35%
Fe (ppm)	1200	Ash	59.87%
Mn (ppm)	110	Moisture	22.00%
Cu (ppm)	56	C/N ratio	16.2 : 1
Zn (ppm)	230		

Four levels of mineral nitrogen were added to soil i.e., (N_1 = 1.5, N_2 = 2.0, N_3 = 2.5 and N_4 = 3.0 kg/tree/year) in the form of ammonium sulphate (20.6 % N) combined with four levels of both potassium and phosphorus i.e., (1.25, 1.50, 1.75 and 2.0 kgs/tree/year) from each one (K_1, K_2, K_3 & K_4) and (P_1, P_2, P_3 and P_4) in the form potassium sulphate (48.0 % K_2O) and monosuper – phosphate (15.5 % P_2O_5) respectively. Each NK level was divided and applied in three split equal doses in the 1st week of Feb., late March and mid-May whereas, P level was added once a year at the third week of December in the two seasons of study. Moreover, three rates of compost compound as solution soil applied i.e., (0.0, 1000 & 2000 ml^3/tree) were added monthly for seven times beginning the 1st week of Feb. till the 1st week of August during in both experimental seasons.

Accordingly, the differential studied treatments used in this study were as follows:

1- $N_1P_1K_1$ soil applied at (1.5, 1.25 & 1.25 kg/tree), respectively + $C_{.0}$ (no compost soil added).
2- $N_1P_1K_1$ soil applied at (1.5, 1.25 & 1.25 kg/tree), respectively + $C_{.1}$ (compost solution at 1000 ml^3) soil applied.
3- $N_1P_1K_1$ soil applied at (1.5, 1.25 & 1.25 kg/tree), respectively + $C_{.2}$ (compost solution at 2000 ml^3) soil applied.
4- $N_2P_2K_2$ soil applied at (2.00, 1.50 & 1.50 kg/tree), respectively + $C_{.0}$ (no compost soil added).
5- $N_2P_2K_2$ soil applied at (2.00, 1.50 & 1.50 kg/tree), respectively + $C_{.1}$ (compost solution at 1000 ml^3) soil applied.
6- $N_2P_2K_2$ soil applied at (2.00, 1.50 & 1.50 kg/tree), respectively + $C_{.2}$ (compost solution at 2000 ml^3) soil applied.
7- $N_3P_3K_3$ soil applied at (2.50, 1.75 & 1.75 kg/tree), respectively + $C_{.0}$ (no compost soil added).
8- $N_3P_3K_3$ soil applied at (2.50, 1.75 & 1.75 kg/tree), respectively + $C_{.1}$ (compost solution at 1000 ml^3) soil applied.
9- $N_3P_3K_3$ soil applied at (2.50, 1.75 & 1.75 kg/tree), respectively + $C_{.2}$ (compost solution at 2000 ml^3) soil applied.
10- $N_4P_4K_4$ soil applied at (3.00, 2.00 & 2.00 kg/tree), respectively + $C_{.0}$ (no compost soil added).
11- $N_4P_4K_4$ soil applied at (3.00, 2.00 & 2.00 kg/tree), respectively + $C_{.1}$ (compost solution at 1000 ml^3) soil applied.
12- $N_4P_4K_4$ soil applied at (3.00, 2.00 & 2.00 kg/tree), respectively + $C_{.2}$ (compost solution at 2000 ml^3) soil applied.

Methodology which has been followed with present investigation is being determined as follows:

1- Vegetative growth measurements:

Were recorded through determining the average shoot length (cm), the average number of leaves per shoot and leaf area surface (cm^2). At the beginning of the growing season, four main branches nearly similar in their diameters well distributed on the canopy of tree (one on each diameter) were labeled to estimate the length of new shoots which developed on these branches which conducted on the first week of April and again repeated on mid-August when growth ceased, the shoot length increase was estimated as following equation:

Shoot length increase = shoot length on mid August – shoot length on April

Moreover both number of leaves per shoot and leaf area (cm^2) were conducted on the last week of August during the two seasons of study.

2- Productivity (kg fruits/tree and ton/feddan):

Tree yield was recorded at the harvesting time in each season, fruits for each tree were picked and weighed in kg, then the average yield per tree (in kg) for each treatment and theoretical yield (tons/fed.) were calculated.

3- Fruit quality:

Samples of 30 mature fruits from each treatment (10 fruits from each replicate) were collected at the harvesting time and the following fruit properties were determined:

3-a. Fruit physical properties: The average fruit weight (g), fruit volume (ml^3), fruit dimensions (both fruit length and width in cm) by vernier caliper and fruit firmness ($Ib/inch^2$) was determined using Magness and Taylor (1980) pressure tester with 7/18 inch plunger.

3-b. Fruit chemical properties: The average percentage of total soluble solids (TSS %) in fruit juice was determined by using a hand refractometer according to A.O.A.C. (2000), fruit juice total acidity percentage was estimated according to Vogel (1968) and TSS/acid ratio was calculated.

4- Leaf mineral content: Leaf nutrient composition of same macro elements i.e., nitrogen, phosphorus and potassium were determined. The following procedures were used:

Total nitrogen (%) was determined by micro-Kjeldahl method as Pregl (1945). While, total P determination was colormeterically carried out according to Murphy and Reily (1962). Moreover, leaf K content was determined by using Atomic absorption spectrophotometer (3300) according to Chapman and Pratt (1961).

Statistical analysis:

Obtained data through the two seasons were subjected to analysis of variance method according to Snedecor and Cochran (1990). However, differences among means of treatments were compared using Duncan's multiple range tested at 5 % level (Duncan, 1955).

RESULTS AND DISCUSSION

1- Response of some vegetative growth measurements:

Considering the average of shoot length (cm), number of leaves/shoot and leaf area (cm^2) of Anna apple trees in response to specific and interaction effects of the two studied factors, data in both seasons are tabulated in Table (3).

A. Specific effect:

Concerning the specific effect of (NPK) soil added rates i.e., ($N_1P_1K_1$, $N_2P_2K_2$, $N_3P_3K_3$ & $N_4P_4K_4$), results in Table (3) clearly revealed that, all investigated growth parameters were responded statistically to the investigated (NPK) levels especially with the highest level ($N_4P_4K_4$). However, treated trees with treatment of ($N_4P_4K_4$) resulted statistically in the highest values and the longest shoots, the highest number of leaves/shoot and the largest leaves in their areas, followed statistically in a descending order by ($N_3P_3K_3$) treatment. On the other hand, the shortest shoots, the least values of both the number of leaves/shoot and the leaf area were exhibited with ($N_1P_1K_1$) treatment which was the inferior during tow seasons of study. Moreover, the treatment of ($N_2P_2K_2$) was ranked statistically an intermediate values the two above mentioned extents. Such trends were detected during both seasons of study.

With regard to the specific effect of compost treatments, data in the same Table displayed obviously that all studied vegetative growth measurements of "Anna" apple trees were responded specifically to the different rates of compost solution as soil applied. However, it could be observed that, the higher rate of compost treatment i.e., (2000 ml^3) soil addition was superior as exhibited significantly the longest shoots, the highest leaves number per shoot and the largest leaf area than those of the two other compost treatments during both seasons of study. On the other side, the reverse was detected by trees treated with compost solution at (0.0 ml^3/no compost addition) which induced statistically the shortest shoots, the least number of leaves per shoot and the smallest leaf area in the two seasons of study. Moreover, treated trees with the rate of (1000 ml^3) compost solution soil added treatment was statistically ranked in between the abovementioned two extremes in most cases. Such trends were true in both 2011 and 2012 seasons of investigation.

B. Interaction effect:

With regard to the response of some measurements of vegetative growth i.e., (shoot length, number of leaves/shoot and leaf area) to the interaction effect of various combination treatments between the two studied factors i.e., (NPK levels and compost solution rates), data presented in Table (3) showed obviously that, the specific effect of each factor was directly reflected on their combinations in the two experimental seasons. Whereas, the combination treatment of ($K_4P_4K_4$ x compost solution at 2000 ml^3) soil applied was the superior as exhibited statistically the highest and greatest values of shoot length, number of leaves/shoot and leaf area in both seasons of study. On the other side, the reverse trend was noticed with trees that subjected to combination treatment of ($N_1P_1K_1$ x 0.0 compost/no added) produced the least significant values of shoot length, number of leaves per shoot and leaf area during both seasons of study. Moreover, other remain combination treatments exhibited intermediate values in their effectiveness compared to the aforesaid two extents. Such trends were detected during both 2011 and 2012 seasons of investigation

These data are generally in an agreement with those previously findings by several investigators Nassef (2000) on pear, Kabeel (2004) on peach; Bussi *et al*., (2003), Kabeel *et al*., (2005) and Kandil and Ahmed (2010) on apricot; Awasthi *et al*., (1997) and Kabeel *et al*., (2007) on apple; Wahba (2007) and Darwesh (2012) on persimmon fruit trees.

Table 3. Influence of different soil applied levels of (NPK) and organic compounds at different levels and their combinations treatments on some vegetative growth measurements during both 2011 and 2012 seasons.

Treatments	Shoot length (cm)				Number of leaves/shoot				Leaf area (cm^2)			
Compost (B) / NPK (A)	C_0	C_1	C_2	Mean	C_0	C_1	C_2	Mean	C_0	C_1	C_2	Mean
						1st season						
$N_1P_1K_1$	52.00f	52.20f	54.23ef	52.18D	24.67e	26.33c-e	27.33b-e	26.11B	42.37f	45.23d-f	46.50c-e	44.70C
$N_2P_2K_2$	55.30d-f	56.90c-e	57.63v-e	56.61C	25.33de	26.67c-e	27.67b-e	26.56B	43.27ef	47.33cd	48.10b-d	46.23C
$N_3K_3P_3$	59.13a-d	60.77a-c	61.17a-c	60.52B	26.33c-e	29.00b-e	30.00b-d	28.44B	46.57c-e	49.20bc	51.30ab	49.02B
$N_4P_4K_4$	60.83a-c	63.17a	64.50a	62.83A	30.67bc	31.67b	36.67a	33.00A	48.67b-d	51.10ab	53.67a	51.14A
Mean	56.82A	58.26A	59.38A		26.75B	28.42AB	30.42A		45.22C	48.22b	49.89A	
						2nd season						
$N_1P_1K_1$	50.20f	51.50ef	54.30de	52.00D	24.50e	26.25c-e	27.56b-e	26.10B	42.67f	44.00ef	46.33de	44.33D
$N_2P_2K_2$	55.63cd	57.20cd	58.33b-d	57.06C	25.21de	26.50c-e	27.90b-e	26.54B	43.53ef	46.87c-e	48.00cd	46.13C
$N_3K_3P_3$	58.30b-d	61.53ab	62.10ab	60.63B	26.30c-e	28.95b-e	30.15b-d	28.47B	46.23de	49.67bc	52.00b	49.30B
$N_4P_4K_4$	61.57ab	64.33a	65.33a	63.74A	30.52bc	31.50b	37.00a	33.01A	49.94bc	52.33b	56.00a	52.77A
Mean	56.42B	58.64A	60.00A		26.63B	28.30AB	30.65A		45.60C	48.22B	50.58A	

Values having the same letter (s) within the same column are not statistically significant using L.S.D. at 5 %.

$N_1P_1K_1$ = 1.5 kg ammonium sulphate, 1.25 kg calcium monnosuper phosphate and 1.25 kg potassium sulphate/tree.

$N_2P_2K_2$ = 2.0 kg ammonium sulphate, 1.50 kg calcium monnosuper phosphate and 1.50 kg potassium sulphate/tree.

$N_3P_3K_3$ = 2.5 kg ammonium sulphate, 1.75 kg calcium monnosuper phosphate and 1.75 kg potassium sulphate/tree.

$N_4P_4K_4$ = 3.0 kg ammonium sulphate, 2.0 kg calcium monnosuper phosphate and 2.0 kg potassium sulphate/tree.

C_0 = non compost. C_1 = 1000 ml compost/tree. C_2 = 2000 ml compost/tree.

2- Productivity (kg fruit/tree and tons per feddan):

Considering the productivity (yields) expressed as kg/tree and tons/ feddan in response to the specific and interaction effects of the two studied factors, obtained data in the two seasons of study are represented in Table (4).

A. Specific effect:

Data obtained during both 2011 and 2012 seasons as shown from Table (4) displayed clearly that, yield of Anna apple trees expressed as kg/tree and ton per feddan were responded specifically to the investigated levels of NPK soil application. However, treated trees with the highest level ($N_4P_4K_4$) treatment exhibited statistically the highest and greatest yield as kg/tree (31.01 & 41.16 kg/tree) and ton per feddan (8.64 & 8.19 ton/fed.) during both seasons of study. On the other side, Anna apple trees received the least NPK level i.e., ($N_1P_1K_1$) treatment induced significantly the lowest values of both fruiting parameter abovementioned (28.71 & 26.96 kg/tree) and (5.66 & 6.03 ton/fed.) in the two seasons of study, respectively. Moreover, both ($N_2P_2K_2$) and ($N_3P_3K_3$) treatments were statistically an intermediate as their yield expressed in kg/tree and ton per fed. were compared to that the abovementioned other (NPK) levels. This trend was detected through two seasons of study.

Referring the specific effect of compost treatments as soil added solution at three rates (0.0, 1000 & 2000 ml^3) on both fruiting parameters abovementioned of Anna apple trees, data in the same Table declared that, trees treated with either 1000 or 2000 ml^3 rates of compost solution resulted in a significant increase in the yield expressed as kg/tree and ton per feddan as compared to trees treated with 0.0 ml3 compost solution (no addition) which was statistically the inferior as induced the least values of yield (29.44 & 30.34 kg/tree) and (6.37 & 6.18 ton/fed.) during both 2011 and 2012 seasons of study, respectively. Moreover, treated trees with the highest levels (2000 ml^3) were statistically the superior as exhibited significantly the highest values and the greatest yield expressed as kg/tree (37.83 & 37.82) and ton per fed. (7.94 & 7.95) in the two seasons of study, respectively. On the other hand, apple trees subjected to compost treatment at (1000 ml^3) soil applied rate recorded in between value the abovementioned two extents (34.13 & 35.58) for tree yield in kg and (7.47 & 7.17) for yield as tons per feddan during both 2011 & 2012, respectively.

B. Interaction effect:

Concerning the interaction effect of the various combinations between various variables of both investigated factors i.e., (NPK x compost) combinations soil applied, data obtained in the same Table revealed obviously that, the highest values and the greatest yield of Anna apple trees either as kg/tree (42.97 & 45.17 kg/tree) or tons per feddan (9.49 & 9.02 ton/fed.) were always significant in relationship to the higher levels of both NPK and compost i.e., ($K_4P_4K_4$ x compost solution at 2000 ml^3) treated trees as soil application in the 1st and 2nd seasons of experimental, respectively. On the other side, the reverse trend was noticed with apple trees treated with treatment of ($N_1P_1K_1$ x no compost) combination which was induced significantly the least values and the lightest crop estimated as kg/tree and ton per feddan. Moreover, the other remained combination treatments were an intermediate the aforesaid two extents with different tendency of response. These trends were observed through 2011 and 2012 seasons of experimental.

Obtained results regarding the response of yield (kg/tree and ton per fed.) at various rates either alone or in combinations are in conformity with those previously reported by many researchers, Yastass (1990), Nassef (2000) and Kabeel and El-Saadaney (2004) on pear; Makhael (1994) and Kabeel *et al*., (2007) on apple; Kabeel *et al*., (2005), Shaddad *et al*., (2005) and Kandil and Ahmed (2010) on apricot; Abou Grah-Fatma (2004), Wahba (2007) and Sharaf *et al*., (2012) on persimmon.

Table 4. Influence of different soil applied levels of (NPK) and organic compounds at different levels either alone or in combinations treatments on fruiting aspects parameters during both 2011 and 2012 seasons.

Treatments	Yield (kg/tree)				Yield (ton/fed.)			
Compost (B) NPK (A)	C_0	C_1	C_2	Mean	C_0	C_1	C_2	Mean
				1st season				
$N_1P_1K_1$	23.07h	29.23f	33.83d	28.71D	4.68f	6.15e	6.16e	5.66D
$N_2P_2K_2$	27.50g	32.23e	35.30c	31.68C	5.89e	7.15d	7.44cd	6.83C
$N_3K_3P_3$	32.03e	36.17c	39.23b	35.81B	7.17d	7.93c	8.68b	7.93B
$N_4P_4K_4$	33.17c	38.90b	42.97a	39.01A	7.76cd	8.66b	9.49a	8.64A
Mean	29.44C	34.13B	37.83A		6.37C	7.47B	7.94A	
				2nd season				
$N_1P_1K_1$	22.27b	29.27f	29.33f	26.96D	4.84f	6.14de	7.11cd	6.03D
$N_2P_2K_2$	28.03g	34.07e	35.43d	32.51C	5.77e	6.77cd	7.41bc	6.65C
$N_3K_3P_3$	34.13e	37.77c	41.33b	37.74B	6.73cd	7.60bc	8.24ab	7.52B
$N_4P_4K_4$	36.93c	41.23b	45.17a	41.16A	7.38bc	8.17ab	9.02a	8.19A
Mean	30.34C	35.58B	37.82A		6.18C	7.17B	7.95A	

Values having the same letter (s) within the same column are not statistically significant using L.S.D. at 5 %.
$N_1P_1K_1$ = 1.5 kg ammonium sulphate, 1.25 kg calcium monnosuper phosphate and 1.25 kg potassium sulphate/tree.
$N_2P_2K_2$ = 2.0 kg ammonium sulphate, 1.50 kg calcium monnosuper phosphate and 1.50 kg potassium sulphate/tree.
$N_3P_3K_3$ = 2.5 kg ammonium sulphate, 1.75 kg calcium monnosuper phosphate and 1.75 kg potassium sulphate/tree.
$N_4P_4K_4$ = 3.0 kg ammonium sulphate, 2.0 kg calcium monnosuper phosphate and 2.0 kg potassium sulphate/tree.
C_0 = non compost. C_1 = 1000 ml compost/tree. C_2 = 2000 ml compost/tree.

3- Fruit characteristics:

1. Fruit physical characteristics:

With respect to the specific and interaction effects of the two studied factor on some physical fruit properties i.e., fruit weight, volume, firmness and dimensions (length and diameter) of apple trees cv. Anna studied through the two seasons of investigation.

A. Specific effect:

Concerning an average weight of fruit (gm), volume (ml^3), length & diameter (cm) of apple fruits Anna cv. As affected by the specific effect of different levels of NPK soil application treatments, it was quite clear from results represented in Tables (5 & 6) that, the investigated physical fruit characters aforesaid were responded specifically. Whereas, it could be noticed from data that, these characters significantly increased by increasing NPK soil added levels. Whereas, the heaviest weight, the biggest volume and the highest values of both length and diameter of fruits were produced from trees subjected to the higher rate treatment ($N_4P_4K_4$). An opposite trend was noticed when apple trees subjected to the treatment of ($N_1P_1K_1$) exhibited significantly the lightest weight, the smallest volume and the least values of both fruit length and diameter in the two seasons of investigation. Moreover, both ($N_3P_3K_3$) and ($N_2P_2K_2$) treatments exhibited fruit were statistically in between values in their average fruit weight, volume, length and diameter during two seasons of study.

Regarding the specific effect of compost compound as soil application, data in the same two Tables aforesaid indicated that, four fruit physical characters abovementioned responded statistically to the rate of compost however, the maximum values of fruit weight (126.0 & 131.0 gms), volume (146.7 & 151.7 ml^3) length (6.66 & 6.65 cm) and diameter (6.33 & 6.34 cm) were associated with the trees which subjected to the highest rates of compost solution (2000 ml^3). On the other hand, the opposite trend was observed with the least rate of compost solution (0.0 or no added rate) which exhibited the lightest weight (107.6 & 110.0 gm), the smallest volume (116.7 & 120.0 ml^3) and the least values of both elongated length (6.27 & 6.29 cm) and widest diameter (5.97 & 5.98 cm). Meanwhile, the abovementioned four fruit physical characters of trees subjected to compost treatment at (1000 ml^3) were significantly an intermediate in comparison with the aforesaid two extents. Such trends were true during the 1st and 2nd seasons of study.

As for specific effect of NPK soil added treatments on fruit firmness, data in Table (5) revealed that, fruit firmness was specifically responded to the investigated levels. However, an obvious decrease in fruit flesh texture was generally exhibited with the higher level ($N_4P_4K_4$) which induced significantly the most softened fruits as compared to those of the other treatments. Contrary, to that, ($N_1P_1K_1$) soil added level exhibited statistically fruits having firmer fruit texture than the other treatments while, other two studied NPK treatments i.e., ($N_3P_3K_3$) and ($N_2P_2K_2$) produced significantly an intermediate values of the two abovementioned extents.

Considering the response of fruit firmness to compost treatments, data showed that, it responded so slight whereas, variances between three treatments were relatively slight and the differences did not reach level of significance as compared each other. Such trends were true during both 2011 and 2012 seasons of study.

Table 5. Some fruit physical properties (fruit weight, volume and firmness) of Anna apple trees in response to specific and interaction effects of (NPK) and organic compounds at different levels either alone or incombinations during 2011 and 2012 seasons.

Treatments	Fruit weight (g.)				Fruit volume (cm^3)				Fruit firmness			
Compost (B) / NPK (A)	C_0	C_1	C_2	Mean	C_0	C_1	C_2	Mean	C_0	C_1	C_2	Mean
						1st season						
$N_1P_1K_1$	94.67e	104.5d	112.7c	103.9D	100.0g	116.7e	125.0d	113.9D	12.00a	11.67ab	11.83ab	11.83A
$N_2P_2K_2$	104.1d	115.2c	117.7c	112.3C	108.3f	126.7d	136.7c	123.9C	10.67bc	10.83a-c	10.67bc	10.72B
$N_3K_3P_3$	114.3c	129.2b	130.7b	124.7B	121.7de	138.3c	158.3b	139.4B	9.83cd	9.83cd	9.83cd	9.83C
$N_4P_4K_4$	117.2c	139.0a	143.2a	133.1A	136.7c	156.7b	166.7a	153.3A	9.67cd	9.00d	8.90d	9.19C
Mean	107.6C	122.0B	126.0A		116.7C	134.6B	148.7A		10.54A	10.33A	10.31A	
						2nd season						
$N_1P_1K_1$	90.0h	106.0g	113.0f	103.0D	95.67h	121.7f	126.7e	114.7D	12.00a	12.60a	11.77ab	12.12A
$N_2P_2K_2$	105.0g	118.0e	120.0e	114.3C	131.7d	131.7d	141.7c	127.7C	10.83b	10.80b	10.80b	10.81B
$N_3K_3P_3$	120.0e	131.0c	140.0b	130.0B	143.3d	143.3c	165.0b	146.9B	9.60c	9.60c	9.50c	9.57C
$N_4P_4K_4$	125.0d	142.0b	151.0a	139.3A	142.3c	161.7b	173.3a	159.1A	9.50c	8.70c	8.67c	8.96D
Mean	110.0C	124.3B	131.0A		120.0C	139.6B	151.7A		10.48A	10.43A	10.18A	

Values having the same letter (s) within the same column are not statistically significant using L.S.D. at 5 %.
$N_1P_1K_1$ = 1.5 kg ammonium sulphate, 1.25 kg calcium monnosuper phosphate and 1.25 kg potassium sulphate/tree.
$N_2P_2K_2$ = 2.0 kg ammonium sulphate, 1.50 kg calcium monnosuper phosphate and 1.50 kg potassium sulphate/tree.
$N_3P_3K_3$ = 2.5 kg ammonium sulphate, 1.75 kg calcium monnosuper phosphate and 1.75 kg potassium sulphate/tree.
$N_4P_4K_4$ = 3.0 kg ammonium sulphate, 2.0 kg calcium monnosuper phosphate and 2.0 kg potassium sulphate/tree.
C_0 = non compost. C_1 = 1000 ml compost/tree. C_2 = 2000 ml compost/tree.

B. Interaction effect:

With regard to the interaction effect of the different (NPK x compost) combinations treatments on weight, volume, length, diameter and firmness of Anna apple fruits, obtained data in Tables (5 & 6) revealed obviously that, the specific effect of each studied factor was reflected directly on the interaction effect of various (NPK x compost) combinations treatments for five physical fruit characters abovementioned. Whereas, trees subjected to the ($N_4P_4K_4$ x compost at 2000 ml^3) combination treatment exhibited significantly the heaviest weight, the biggest volume, the highest and greatest values of fruit length and diameter while a significant decrease in fruit flesh firmness was induced with treatment as compared to ($N_1P_1K_1$ x compost at 0.0 ml^3) combination treatment which produced statistically the lightest, smallest, the least values of length

and diameter of apple fruits as well as fruits having firmer flesh texture. Moreover, the remained combination treatments were an intermediate the abovementioned two extremes from the standpoint of statistic. Such trends were detected through the two investigation.

The present results concerning the response of studied fruit physical properties to the investigated treatments under study are in agreement with those mentioned by Yastass (1990), Nassef (2000) and Kabeel and El-Saadaney (2004) on pear; Makhael (1994), Awasthi *et al*., (1997) and Kabeel *et al*., (2007) on apple; Kabeel (2004), on peach; Shaddad *et al*., (2005) and Kandil and Ahmed (2010) on apricot and Sharaf *et al*., (2012) on persimmon.

Table 6. Some fruit physical properties (fruit length and diameter) of Anna apple trees in response to specific and interaction effects of (NPK) and organic compounds at different levels either alone or incombinations during 2011 and 2012 seasons.

Treatments	Fruit length (cm.)				Fruit diameter (cm.)			
Compost (B) / NPK (A)	C_0	C_1	C_2	Mean	C_0	C_1	C_2	Mean
				1st season				
$N_1P_1K_1$	5.80c	6.15bc	6.22bc	6.06B	5.70c	5.90c	6.00c	5.87C
$N_2P_2K_2$	6.18bc	6.38a-c	6.45a-c	6.34B	5.97c	6.00c	6.07bc	6.01BC
$N_3K_3P_3$	6.43a-c	6.67ab	6.98a	6.69A	6.07c	6.23a-c	6.57ab	6.29AB
$N_4P_4K_4$	6.67ab	6.72ab	7.00a	6.80A	6.13a-c	6.67a	6.67a	6.49A
Mean	6.27B	6.48B	6.66A		5.97B	6.20A	6.33A	
				2nd season				
$N_1P_1K_1$	5.86c	6.18bc	6.21bc	6.08B	5.73c	5.98c	6.00c	5.92C
$N_2P_2K_2$	6.15bc	6.41a-c	6.47a-c	6.33B	6.00c	6.00c	6.08bc	6.03BC
$N_3K_3P_3$	6.45a-c	6.68ab	6.98a	6.70A	6.06bc	6.21a-c	6.58ab	6.28AB
$N_4P_4K_4$	6.68ab	6.75ab	7.00a	6.81A	6.14a-c	6.70a	6.68a	6.51A
Mean	6.29B	6.51B	6.65A		5.98B	6.22AB	6.34A	

Values having the same letter (s) within the same column are not statistically significant using L.S.D. at 5 %.
$N_1P_1K_1$ = 1.5 kg ammonium sulphate, 1.25 kg calcium monnosuper phosphate and 1.25 kg potassium sulphate/tree.
$N_2P_2K_2$ = 2.0 kg ammonium sulphate, 1.50 kg calcium monnosuper phosphate and 1.50 kg potassium sulphate/tree.
$N_3P_3K_3$ = 2.5 kg ammonium sulphate, 1.75 kg calcium monnosuper phosphate and 1.75 kg potassium sulphate/tree.
$N_4P_4K_4$ = 3.0 kg ammonium sulphate, 2.0 kg calcium monnosuper phosphate and 2.0 kg potassium sulphate/tree.
C_0 = non compost. C_1 = 1000 ml compost/tree. C_2 = 2000 ml compost/tree.

2. Fruit chemical characteristics:

A. Specific effect:

Concerning the specific effect of both investigated factors (NPK) and (compost) treatments alone on some fruit chemical characters i.e., (TSS %, acidity % and TSS/acid ratio). Results presented in Table (7) clearly that, the richest fruits and the highest significant values in their content of both TSS % and TSS/acid ratio were induced by trees supplied with ($N_4P_4K_4$, $N_3P_3K_3$ and $N_2P_2K_2$) treatments, respectively however, differences between the three levels did not reach level of significance. Whereas, the trend was typically observed with fruit juice acidity % but the differences between the four levels of NPK were equal from the standpoint of statistic. On the other hand, the lowest level of NPK i.e., ($N_1P_1K_1$) treatment had significantly the least values and the lowest fruits in their TSS %, total acidity % and TSS/acid ratio contents. Such trends were true during both 2011 and 2012 of experimental seasons.

As for the specific effect of compost solution treatments on aforesaid fruit chemical properties of "Anna" apple trees, data in the same Table revealed obviously that, the response was typically followed the same trend previously detected with the abovementioned factor (NPK). Meanwhile, the highest statistical values and the richest fruits in their content of TSS %, acidity and TSS/acid ratio were always in concomitant to those apple trees treated with both treatments of compost solution soil applied at rates of (2000 and 1000 ml^3) but the differences between the two rates of compost treatments did not reach level of significance. This trend was true through the 1st and 2nd seasons of experimental.

B. Interaction effect:

With respect to the interaction effect of various combinations between the variables of both investigated factors i.e., (NPK x compost solutions) soil applied levels on both TSS % and TSS/acid ratio contents in fruit juice, data tabulated in Table (7) indicated that, the different combinations treatments of (NPK x compost) increased generally its values during the two seasons of study. Moreover, the trees subjected to the ($N_4P_4K_4$ x 2000 ml^3 of compost) combination treatment exhibited generally the highest values and the richest fruit juice of both TSS % and TSS/acid ratio contents during 2011 and 2012 seasons of study. From the other view, the reverse trend was true and noticed with the ($N_1P_1K_1$ x 0.0 of compost) combination treatment which was statistically the inferior as exhibited the lowest value and the poorest fruits in their contents of both TSS % and TSS/acid ratio in the two seasons of study. In addition, the remain combination were in between values to the abovementioned two extremes from statistical standpoint. As for the response of total acidity %, data in the same Table indicated clearly that, the absent of significance differences in the response of total acidity % to interaction effect of all investigated combination treatments were detected whereas, the differences between all combination treatments were so little to reach level of significance during both first and second of experimental seasons of investigation.

The present data concerning the response of studied chemical fruit properties to the effect of abovementioned investigated treatments are an agreement with those reported by many researchers, Yastass (1990), Nassef (2000) on pear; Makhael (1994) and Awasthi *et al*., (1997) and Kabeel *et al*., (2007) on apple; Kabeel *et al*., (2005), Shaddad *et al*., (2005) and Kandil and Ahmed (2010) on apricot; Abou Grah-Fatma (2004), Wahba (2007), Darwesh (2012) and Sharaf *et al*., (2012) on persimmon.

Table 7. Some fruit chemical properties (TSS %, acidity % and TSS/acid ratio) of Anna apple trees in response to specific and interaction effects of (NPK) and organic compounds at different levels either alone or incombinations during 2011 and 2012 seasons.

Treatments	TSS (%)				Acidity (%)				TSS/acid ratio			
Compost (B) NPK (A)	C_0	C_1	C_2	Mean	C_0	C_1	C_2	Mean	C_0	C_1	C_2	Mean
1st season												
$N_1P_1K_1$	10.00d	11.00ac	11.17ab	10.72B	0.450a	0.437a	0.467a	0.451A	22.22cd	25.17a	23.92b	23.77A
$N_2P_2K_2$	10.00d	11.67a	11.50a	11.06A	0.467a	0.450a	0.500a	0.472A	21.41	25.93a	23.00bc	23.45A
$N_3K_3P_3$	10.67b-d	11.67a	11.50a	11.28A	0.467a	0.500a	0.533a	0.500A	22.85c	23.34b	21.58d	22.59B
$N_4P_4K_4$	10.33cd	10.50b-d	11.67a	11.83A	0.500a	0.533a	0543a	0.526A	20.66e	19.70f	21.49d	20.62C
Mean	10.25B	11.21A	11.46A		0.471A	0.480A	0.511A		21.79BC	23.54A	22.50B	
2nd season												
$N_1P_1K_1$	10.50c	10.90bc	11.33ab	10.91B	0.440a	0.460a	0.470a	0.457A	23.86c	23.70c	24.11b	23.89A
$N_2P_2K_2$	10.60c	11.77a	11.50a	11.29A	0.450a	0.457a	0.490a	0.466A	23.56cd	25.75a	23.47cd	24.26A
$N_3K_3P_3$	10.80bc	11.60a	11.57a	11.32A	0.447a	0.470a	0.510a	0.476A	24.16b	24.68ab	22.69d	23.84A
$N_4P_4K_4$	10.90bc	11.67a	11.57a	11.38A	0.490a	0.490a	0.520a	0.500A	22.24d	23.82c	22.25d	22.77B
Mean	10.70B	11.48A	11.49A		0.457A	0.469A	0.498A		23.46B	24.49A	23.13B	

Values having the same letter (s) within the same column are not statistically significant using L.S.D. at 5 %.
$N_1P_1K_1$ = 1.5 kg ammonium sulphate, 1.25 kg calcium monnosuper phosphate and 1.25 kg potassium sulphate/tree.
$N_2P_2K_2$ = 2.0 kg ammonium sulphate, 1.50 kg calcium monnosuper phosphate and 1.50 kg potassium sulphate/tree.
$N_3P_3K_3$ = 2.5 kg ammonium sulphate, 1.75 kg calcium monnosuper phosphate and 1.75 kg potassium sulphate/tree.
$N_4P_4K_4$ = 3.0 kg ammonium sulphate, 2.0 kg calcium monnosuper phosphate and 2.0 kg potassium sulphate/tree.
C_0 = non compost. C_1 = 1000 ml compost/tree. C_2 = 2000 ml compost/tree.

Some leaf macro elements content (N, P and K):

A. Specific effect:

With regard to the leaf nitrogen, phosphorus and potassium contents of Anna apple trees in response to specific effect of NPK soil added rates. It's quite evident from obtained data in Table (8) that, a firm trend was obviously detected. However, leaf content of some macro-nutrient i.e., (nitrogen, phosphorus and potassium) were increased significantly with increasing NPK soil applied levels. Whereas, the greatest amounts and the richest leaves in their N, P and K contents were statistically inclosed relationship with the highest level ($N_4P_4K_4$) soil added followed in a descending order by both ($N_3P_3K_3$) and ($N_2P_2K_2$) soil applied treatments, respectively. On the other hand, the lowest level of NPK i.e., ($N_1P_1K_1$) resulted significantly in the least value and the poorest leaves N, P and K contents. Moreover, differences between the four NPK investigated levels with the leaf content of N, P and K were significant. Such trends were observed and true in both 2011 and 2012 seasons of investigation.

With respect to the response of abovementioned investigated leaf N, P and K content to the specific effect of different rates of compost compound solutions as soil application, data in the same Table showed obviously that, leaf N, P and K contents were positively responded to the investigated rates of compost compound solutions as soil applied. However, either rates of compost compared at (2000) or (1000 ml^3) soil added treatments were the superior which exhibited the richest leaves and the highest significant values of nitrogen, phosphorus and potassium contents in all cases through the two seasons. The opposite trend was true with those of the latter treatment i.e., (no added compost compound) which was statistically the inferior as produced the lowest values in their contents nitrogen, phosphorus and potassium in leaves. This trend was detected through 1st and 2nd experimental seasons of study.

B. Interaction effect:

As for the interaction effect of the various (NPK + compost solution) combination treatments at different rates on some leaf macro-nutrients i.e., nitrogen, phosphorus and potassium contents of Anna apple trees, data tabulated in Table (8) indicated clearly that, treated trees with the ($N_4P_4K_4$ x compost at 2000 ml^3) combination treatment exhibited generally the richest leaves and the highest significant values in their nitrogen, phosphorus and potassium contents during both seasons of investigation. Moreover, the superiority of the aforesaid treatment over the other studied combination treatments was obviously noticed in both seasons of experimental investigation. On the other hand, an opposite trend was detected with trees treated with ($N_1P_1K_1$ x compost at 0.0 ml^3) combination treatment which was significantly the inferior as exhibited the lowest statistical values and the poorest leaves in their nitrogen, phosphorus and potassium contents during the two seasons of study. Whereas, the other combination (NPK x compost) treatments were statistically ranked an intermediate the aforesaid two extremes with tendency of variability in their effectiveness. Such trends were true during both 2011 and 2012 seasons of study.

Obtained data regarding the response of some macro-nutrients (nitrogen, phosphorus and potassium) contents in the leaves of Anna apple trees to studied treatments under this investigation were in a general

agreement with the results found by Awasthi *et al*., (1997) and Kabeel *et al*., (2007) on apple; Nassef (2000) and Kabeel and El-Saadaney (2004) on pear; Bussi *et al*., (2003), Kabeel *et al*., (2005), Shaddad *et al*., (2005) and Kandil and Ahmed (2010) on apricot; Kabeel (2004), and Talyor (2009) on peach; Abou Grah-Fatma (2004), Wahba (2007) and Darwesh (2012) on persimmon.

Table 8. Influence of some macro-nutrients (nitrogen, phosphorus and potassium) contents of Anna apple trees to specific and interaction effects of (NPK) and organic compounds at different levels either alone or incombinations during 2011 and 2012 seasons.

Treatments	N (%)				P (%)				K (%)			
Compost (B) NPK (A)	C_0	C_1	C_2	Mean	C_0	C_1	C_2	Mean	C_0	C_1	C_2	Mean
						1st season						
$N_1P_1K_1$	1.50e	1.57de	1.62de	1.56D	0.220h	0.307ef	0.313d-f	0.280D	1.20e	1.33cd	1.34b-d	1.29C
$N_2P_2K_2$	1.61de	1.68c-e	1.72b-d	1.67C	0.260g	0.320de	0.338c	0.306C	1.26de	1.37bc	1.39a-c	1.34BC
$N_3K_3P_3$	1.70b-d	1.87a-c	1.89ab	1.82B	0.300f	0.340c	0.363b	0.334B	1.33cd	1.40a-c	1.43a-c	1.39B
$N_4P_4K_4$	1.83a-c	2.00a	2.00a	1.94A	0.330cd	0.363b	0.383a	0.359A	1.40a-c	1.45ab	1.49a	1.45A
Mean	1.66B	1.78A	1.81A		0.278C	0.333B	0.349A		1.30B	1.39A	1.41A	
						2nd season						
$N_1P_1K_1$	1.56g	1.61fg	1.67fg	1.61D	0.230g	0.307de	0.303d-f	0.280D	1.23i	1.35gh	1.37fg	1.32D
$N_2P_2K_2$	1.64fg	1.73ef	1.75d-f	1.71C	0.260f	0.320de	0.340e	0.307C	1.30h	1.44d-f	1.42d-f	1.39C
$N_3K_3P_3$	1.75d-f	1.87c-e	1.95bc	1.86B	0.300e	0.350c	0.373ab	0.341B	1.37e-g	1.45b-d	1.48a-c	1.43B
$N_4P_4K_4$	1.88cd	2.07ab	2.12a	2.02A	0.340c	0.370b	0.390a	0.367A	1.43c-e	1.49ab	1.53a	1.48A
Mean	1.71B	1.82A	1.87A		0.283C	0.337B	0.352A		1.33B	1.43A	1.45A	

Values having the same letter (s) within the same column are not statistically significant using L.S.D. at 5 %.
$N_1P_1K_1$ = 1.5 kg ammonium sulphate, 1.25 kg calcium monnosuper phosphate and 1.25 kg potassium sulphate/tree.
$N_2P_2K_2$ = 2.0 kg ammonium sulphate, 1.50 kg calcium monnosuper phosphate and 1.50 kg potassium sulphate/tree.
$N_3P_3K_3$ = 2.5 kg ammonium sulphate, 1.75 kg calcium monnosuper phosphate and 1.75 kg potassium sulphate/tree.
$N_4P_4K_4$ = 3.0 kg ammonium sulphate, 2.0 kg calcium monnosuper phosphate and 2.0 kg potassium sulphate/tree.
C_0 = non compost. C_1 = 1000 ml compost/tree. C_2 = 2000 ml compost/tree.

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تأثير الإضافات الأرضية بمعدلات مختلفة من النتروجين والفوسفور والبوتاسيوم والكمبوست على النمو والمحصول وصفات جودة الثمار ومحتوى الورقة من العناصر الغذائية لأشجار التفاح صنف "آنا"

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أجري هذا البحث بهدف دراسة تأثير الإضافة الأرضية بمعدلات مختلفة من التسميد المعدني (ن، بو، فو) والتسميد العضوي (الكمبوست) سواء كانت هذه المعدلات منفردة على حدة أو متداخلة معاً في تراكيب وذلك على بعض قياسات النمو الخضري والثمري وصفات جودة الثمار وكذلك محتوى الأوراق من بعض العناصر الكبرى لأشجار التفاح صنف (أنا) والنامية تحت ظروف محطة بحوث البساتين بالقناطر الخيرية خلال موسمين متتاليين ٢٠١١، ٢٠١٢.ولقد أشارت النتائج المتحصل عليها إلى أن معظم معاملات التسميد المعدني أو العضوي سواء منفردة أو متداخلة معاً في هذه الدراسة أدت إلى تأثير إيجابي وزيادة معنوية لكل قياسات النمو الخضري المختبرة (طول الفرع – عدد الأوراق لكل فرع – المساحة الورقية) كذلك فإن قياسات الإثمار (كمية المحصول معبراً عنها بالكيلو جرام/شجرة أو بالطن/فدان) قد ازدادت معنوياً بزيادة معدلات الإضافة لمعظم المعاملات تحت الدراسة في كلا موسمي التجربة.أيضا فإن النتائج المتحصل عليها أوضحت أن صفات جودة الثمار سواء الطبيعية والتي تشمل (وزن الثمرة – الحجم – الصلابة – ارتفاع وقطر الثمرة) او الصفات الكيماوية مثل (النسبة المئوية للمواد الصلبة الذائبة الكلية – النسبة المئوية للحموضة الكلية – معدل النسبة بينهما) قد تحسنت معنويا نتيجة الإضافة الأرضية بالمعاملات المختلفة للأشجار وبصفة خاصة عند الإضافة الأرضية بالمعدلات الأعلى من التسميد المعدني والتسميد العضوي سواء في حالة منفردة أو في حالة التراكيب (التداخل معاً) إذا ما قورن ذلك بالمعدلات الأقل. إضافة إلى ذلك فإن المحتوى الغذائي للورقة من بعض العناصر الغذائية الكبرى (ن، فو، بو) قد ازدادت وتحسنت بصفة عامة من الناحية الإحصائية نتيجة المعاملات المختلفة تحت الدراسة خلال موسمي الدراسة. وبصفة عامة فإنه يمكن القول بأن معظم معاملات الإضافة الأرضية من التسميد المعدني أو العضوي سواء منفردة أو متداخلة معاً أدت إلى تأثيرات إيجابية ومعنوية على كل قياسات النمو الخضري وقياسات الإثمار المدروسة وكذلك على معظم صفات جودة الثمار ومحتوى الأوراق من العناصر لأشجار التفاح "أنا" وعلاوة على ذلك فقد أظهرت النتائج أن المعدل الأعلى من كل من (ن، فو، بو) والكمبوست معاً (ن٤، فو٤، بو٤ × الكمبوست ٢٠٠٠ مل) كانت أفضل المعاملات وأكثرها فعالية في زيادة النمو والمحصول وتحسين الحالة الغذائية للأوراق ومعظم صفات الجودة لثمار التفاح.