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The impact of NPK mineral, bio-organic fertilizers and some stimulants on flowering and fruiting of Le-Conte pear trees

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ABSTRACT

This investigation was carried out through 2014-2017 years in an evaluation attempt the response of flowering, fruiting and fruit quality attributes of ten-year-old Le-Cont pear trees to manipulation with NPK chemical and organic fertilizers, some soil amendments (humic acid, magnetic iron, bio fertilizers) and foliar stimulants (bentocide, amino fert and K-silicate). The results indicate that blooming spurs%, fruit length, fruit diameter, TSS, total sugars% and juice vitamin "C" content were highly improved with NPK mineral + organic fertilizers each at 50% (A), A+ bio fertilizers at 30g/tree + humic acid at 5cm/L + magnetic iron at 500g/tree (B), B combined with either bentocide at 5g/L (C) or amino fert at 2.5ml/L (D) or K-silicate at 8ml/L (E). Meanwhile, number of spurs/branch and TSS/acid ratio were enhanced with treatments C,D and E, in spite of number of flowers / spur character did not affect by neither one of the studied treatments. The highest significant values of fruit set%, No. of fruits/tree; fruit yield; fruit weight and fruit size were framed with (C) and (E) treatments only. On the other hand, the least values of the abovementioned parameters were associated with NPK organic fertilizer at 100% level solely.

Key words: magnetic iron, K-silicate, bento cide, amino fert.

Introduction

Pear (*pyrus spp*.) is native to family Rosaceae. Pear is one the most consumed fruit all over the world. It is due to, not only to preference of fruit consumers, but also because it is a most valuable raw material for genuine natural beverage product. "Le-cont" pear (*pyrus communis* L.X *pyrus pyrifolia* N.) budded on *pyrus betulaefolia* rootstock is grown and widely spread in new reclaimed land in Egypt.

In the last 20 years the pear cultivated area in Egypt decreased from 14923 Fadden in 1995 to 13265 Fadden in 2015 (Egyptian Ministray of Agriculture statistics 2015). Most of this area is concentrated in Lower Egypt especially in Al-Behera, Alexandria, Menofia, and Kalubia governorates. This decrease is due to many factors including fire blight, aging, type of rootstock, insufficient chilling in some years and other unfavorable factors. However, Kassem and Marzouk (2002) found that the high cost of mineral fertilization is the big problem facing pear growers. In addition, the recent researches revealed that mineral fertilizers have a role in the health problems and environmental pollution (Kabeel *et al*., 2005).There is a need to offer the consumer with safety pear product by using organic fertilization.

Sandy soil considered one of the problems that facing pear extension in Egypt as those soils are very poor in organic matter that have low exchange and low water holding capacity which lead to more losses of fertilizers through leaching. A great attention has been carried out to use organic manures for minimizing the uses of chemical fertilization, and in turn improving soil texture and fertility.

Organic agriculture is an ecological management system that promotes and enhances biodiversity, biological cycles and soil biological activates. It is based on the minimal use of off–farm and chemical inputs and management practices that restore maintain and enhance ecological harmony. Therefore, a great attention has been paid to using the natural source of nutrition as an alternative to the mineral fertilization, but organic fruit growers have little experience with stone

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fruits. However, (Zhou *et al.,* 2001) out lined that one of the most important factor of organic fruit production is using the organic fertilization as it improve physical, chemical and biological properties of nearly all soil types; adjusting soil pH and increasing solubility production of the plants. Some investigators studied the effect of organic manure application as compared with chemical fertilizer on different fruit crops (Fayed, 2005) on apple and (Mohammed *et al.,* 2010) on pear, They reported that, under organic system soil biotic life increased as a result of the plant synthesis of more vitamins and amount of total sugar.

Bio-fertilizers are the most importance for plant production and soil as they play an important role in increasing vegetative growth, yield and fruit quality (Fayed, 2005) on apple. Also, El-Naggar (2009) revealed that, leaf content of (N, P, K, Ca, Mg, Fe, Zn and Mn) responded significantly to Nitrobein, Phosphorene and active dry yeast.

Humic acid (polymeric polyhydroxy acid) was the most significant component of organic substances in aquatic system. Humic acid is highly beneficial to both plants and soil, increase microbial and mycorrizal activity, a plant growth bio-stimulant, an effective soil enhancer, promote nutrient uptake (chelating agent) and increase crops yield (Abdou, 2010) on "Le-Conte" pear trees. Additionally, humic materials have a positive effect on rhizosphere count of various groups of determined organisms of "Canino" apricot which reflects on growth, yield and fruit quality attributes (Fathy *et al.,* 2010).

In addition, Fawzia- Eissa *et al*. (2007 a, b) revealed that humic acid application (especially soil treatment with 20 ml/tree, every week from July 1st to October 15th) markedly minimized the harmful effect of salinity and enhanced apricot, pear, peach apple and salt tolerance.

The effect of liquid organic fertilizer such as aminofert was to avoid the harmful effect of using hormones the influence of polyamines in increasing fruit set has been observed in apple (*Malus domestica* Borkh*.)* and Comice pear. Particularly in Comice pear. It has been suggested that polyamines reduce senescence rates in some plant tissues by antagonism with ethylene, possibly by competing for S-adenosylmethionine, a common precursor of both plant bio-regulators (Franco-Mora *et al.,* 2005).

Magnetite (Magnetic iron) is one of the most important factors affecting plant growth. It's one of two natural row rocks in the world that is naturally magnetic Mansour (2007). Magnetite may be play an important role in cation uptake capacity and has a positive effect on immobile plant nutrient uptake Esitken (2003), and Magnetic field could be substitution of chemical additives, which can reduce toxins in raw materials and these raise the food safety.

Potassium silicate is a source of highly soluble potassium and silicon. It is used in agricultural production systems primarily as a silica amendment, and has the added benefit of supplying small amounts of potassium. Silicon is one of the abundant elements in the lithosphere and it is the most abundant element in soil next to oxygen and comprises 28 per cent of its weight and 3-17 percent in soil solution the function of Si as a protective agent is one of the most important for plants. Improved Si nutrition has been shown to increase plant tolerance to a biotic stresses such as Al, Mn, heavy metal toxicities, salinity, frost and drought (Epstein 1999).

Mode of action for Bento cide (micro – elements) was explained by Larue and Johnson (1989) who found that Iron (Fe) complexes with proteins to form important enzymes in the plant and is associated with chloroplasts where it has some roles in the synthesizing chlorophyll. In addition Mn is a minor constituent of plant chlorophyll which is responsible for photosynthesis and metabolism of both nitrogen and carbohydrate. B is known as a transported element of sugars and increase of carbohydrate movement from leaves into fruit tissue (Dugger, 1983). Zinc (Zn) plays a role in treptophan synthesis which is the precursor of endogenous natural hormone (IAA) which is necessary for all plants metabolic processes. Increasing rates of foliar application of all nutrient treatments 1%, 2% and 3% of (K_2SO_4, $ZnSO_4$, H_3BO_3 and Ca chelated) at full bloom and one month after fruit setting increased the TSS%. While it was noticed that, all foliar application of K and B decreased acidity content of "Anna" apple fruits Aly *et al*., (2014).

The main objective of this study, is to carry out a comparison between using organic manure (compost) or inorganic (NPK) fertilizer or the combination between them as a source of NPK soil fertilization in the presence of some soil amendements and foliar stimulants in order to know which soil amendement, foliar tonic and NPK fertilizer source more beneficial for growth and

productivity of pear trees " Le-Conte " cv. grown under Ismailia Governorate conditions as well as to be more safety for human health.

Materials and Methods

This investigation was carried out on ten - year - old Le-Conte pear trees (*pyrus communis* L.X *pyrus pyrifolia* N.) budded on *pyrus betulaefolia* rootstock, planted at 5 × 5 meters apart (168 trees / feddan) grown in sandy soil under drip irrigation system at El-Kassasien Horticultural Research Station, Ismailia Governorate during two successive experimental seasons through 2014-2017 years. Each experimental season was started in early December (2014&2015) and terminated in mid-September (2016&2017) during 1st and 2nd ones, respectively. Forty fruitful pear trees were carefully selected and devoted for this work. These trees were similar in their growth vigor, size shape and diseases - free as well as they received the same culture managements adopted in this Station. Mechanical and chemical analysis of orchard soil have been carried out Prior to the first season according to the methods described by Piper (1947) as shown in Table (1).

Table 1: Physical and chemical analysis of the experimental Orchard soil.

Physical characteristics %		Chemical characteristics	
Field capacity	11.77	$CaCO_3$ %	12.95
Available water	7.57	Organic matter%	0.09
Wilting point	4.20	pH	7.5
Coarse sand	67.88	EC (ds/m)	0.13
Fine sand	11.1	Ca(mg/100g)	0.14
Silt	1.5	Na (mg/100g)	0.34
Clay	5.9	K (mg/100g)	0.16
Texture class	Sandy	Cl (mg/100g)	0.30

The Application Method of Chemical Fertilizers:

Two rates of chemical fertilizers NPK were employed in this study. The first rate was 100% of NPK (385, 80 and 390g of N, P and K (pure units) per tree, respectively). The second rate was 50% of the 1st NPK rate i.e., (192.5, 40and 195 g of N, P and K per tree, respectively).

The chemical fertilizers were added into two equal doses at the first week of February and two weeks later of fruit set through drip irrigation system. Ammonium nitrate (NH_4NO_3, 33.5 % N) at 1149 g, mono Calcium phosphate (15.5 % PO_5) at 516 g and potassium sulphate (K_2SO_4- high soluble 50% K $_2O$) at 780 g were used as a source of N, P and K respectively to release 385,80,390g of NPK units.

The Application Method of Organic manure:

Two rates of organic manure fertilizer (compost) were used, the first rate was 100% level (33.5 kg compost per tree), such rate release 385, 80and 390g (pure units) of N, P and K per tree respectively. and equivalent to the same quantities delivered by using the recommended mineral NPK fertilizers by the Ministry of Agriculture from the other one. The second rate was 50% level (16.75 kg compost per tree).The chemical analysis of organic manure (compost) shown in Table (2).

Rate and application method of Bio-fertilizers:

Three types of bio-fertilizers were investigated throughout this study. (Nitrobein–Phosphorene - Potassein).

Rate and application date of humic acid:

Green power as a Humic acid source was added as soil application in liquid form in four equal doses (December, March, May and July) at 5 ml/L. Green power contains (10% humic acid+10% amino acid).

Table 2: Chemical analysis of organic manure (compost)

Parameter	Mature form compost
Cubic meter weight kg	520
Moisture%	33.5
Organic matter%	45.70
pH(1:10)	7.40
EC (ds/m)	2.3
C/N ratio	22:1
Total N%	1.15
Total P%	0.24
Total K%	1.17
Total Ca%	1.95
Total Mg%	0.86
Total Fe (ppm)	1990
Total Mn (ppm)	430
Total Zn (ppm)	130
Total Cu (ppm)	30
Other mineral constituents%	16

The Application date and Method of amino organic acids:

Amino organic acids growth stimulant (in the commercial name of amino fert) was sprayed at the rate of 2.5 ml/L every other week starting from full bloom till July.

The Application Method of Magnetic iron:

The used magnetite (Magnetic iron), contained 8.8% FeO, 26.7 % Fe2O3, 2.6% MgO, 4.3% SiO2 and 0.3%CaO, The magnetite (magnetic iron) was soil applied at the rate of 500g/tree/year on Dec.

The Application Method of Bento cide:

Bento cide was sprayed every other 2weeks at the rat of 5g/L/ started from full bloom till July.

The Application Method of Potassium Silicate:

Potassium Silicate (10%K2O + 25%SiO2) was sprayed every other 2weeks each doses at the rate of 8 ml/L/ from full bloom till July.

So, the investigated materials were arranged and designed in different combinations in order to build up the skeleton of the following investigated treatments:

T1. NPK 100 % (control).
T2. Compost 100%.
T3. Compost 100% + bio-fertilizers.
T4. Compost 100% + Humic acid (Green power).
T5. Compost 100% + Magnetic iron.
T6. NPK 50 % + Compost 50%.
T7. NPK 50 % + Compost 50% + bio-fertilizers + Humic acid + Magnetic iron.
T8. NPK 50 % + Compost 50% + bio-fertilizers + Humic acid + Magnetic iron +Bento cid.
T9. NPK 50 % + Compost 50% + bio-fertilizers + Humic acid + Magnetic iron +Amino fert.
T10. NPK 50 % + Compost 50% + bio-fertilizers + Humic acid + Magnetic iron + k-silicate.

The Complete randomized block design was used for arranging the abovementioned ten treatments, whereas each treatment was replicated four times and each replicate was represented by an individual pear fruit tree.

Methodology which has been followed in this study is being determined as follows:

Flowering behavior.

Four branches with the same age (more than two years) were selected on each tree and the following three flowering parameters were counted and estimated.

a- Number of spurs / one meter long of branch.
b- Percentage of blooming spurs.
c- Average number of flowers per spur.

Fruiting measurements.

Initial Fruit set percentage.

The total number of flowers of the four labeled limbs per each individual tree were counted in both seasons of study. Three weeks later of the blooming No of the developed fruitlets on each branch was counted and recorded. Then fruit set % was calculated according to the following equation.

$$\text{Fruit set \%} = \frac{\text{Total No. of developed fruitlets}}{\text{Total No. of flowers}} \times 100$$

Yield (kg/tree)

The fruits were harvested on 25th of July and the 2nd of August in 2016 and 2017 during1st and 2nd seasons respectively, total yield was expressed as total of either number or weight of harvested mature fruits/tree

Samples of twenty mature fruits at harvesting time from each tree were randomly collected and the following measurements of both physical and chemical properties were determined as follows:

Fruit physical characteristics:

The average values of fruit weight (gm), fruit size (volume cm^3), fruit length (cm.), fruit diameter (cm), fruit shape index (fruit length /fruit diameter ratio), and fruit firmness ($Lb/inch^2$) were estimated.

Fruit chemical characteristics:

Fruit flesh total soluble solids percentage (T.S.S %):

TSS was determined using ATAGO (ATC-No.1) hand refractometer (Mika *et al.,* 1982).

Fruit flesh total titratable acidity percentage:

It was determined in terms of anhydrous malic acid as a percentage after titration by 0.1 N sodium hydroxide using phenolphthalein as described in A.O.A.C. (1995) by using following equation

$$\text{Total acidity (\%)} = \frac{\text{Na OH volum} \times 0.1 \times 0.064}{\text{Juice volume (ml)}} \times 100$$

T.S.S/acid ratio:

Total sugars content: Were determined calorimetrically according to the method described by Dubais *et al.* (1956).

Ascorbic acid (V.C mg/100ml/juice) was determined, according to A.O.A.C. (1995).

Statistical analysis:

All the obtained data in the two seasons of study were statistically analyzed using the analysis of variance (ANOVA) according to Snedecor and Cochran (1980). However, means were

distinguished by the M.Static program was used to compare between means of treatments according to (Waller and Duncan, 1969) at probability of 5%.

Results and Discussion

Flowering behavior:

1. Number of spurs/branch:

Regarding No. of spurs/branch of Le-Conte pear trees, data presented in Table (3) indicate that there were significant differences among the studied treatments.

Herein, the highest values of the studied parameter were associated with T7 coupled with either bento cide (T8) or amino-fert (T9) or K-silicate (T10) as those three treatments alleviated the studied parameter to the maximum level as compared with the other treatments during both seasons of study.

On the other hand, the least value of such parameter was detected with either the fertilization with NPK in organic (compost) form at 100 % level (T2) or T2 combined with magnetic iron (T5). The other five investigated treatments were in between the two abovementioned extents. Such trend was true during both seasons of study.

Table 3: Effect of NPK source (mineral & organic), level and their combinations with some stimulants (3 bio NPK fertilizers), magnetic-Fe, K-silicate and (amino/organic acids) on No. of spurs/branch, blooming spurs (%) and No. of flowers/spur of "Le-Conte" pear trees during 2014-2016 and 2015-2017 experimental seasons**.**

Evaluated parameters	No. of spurs/branch		Blooming spurs (%)		No. of flowers/spur	
Seasons / Investigated treatments	2016	2017	2016	2017	2016	2017
T1-Mineral NPK 100% (control)	16.31 B	17.62 B	59.21 B	60.18 B	5.79 A	6.73 A
T2- Compost 100%	14.18 C	14.00 C	60.73 B	59.88 B	5.81 A	6.81 A
T3-(T2+NPK Bio fertilizer)	16.41 B	16.67 B	58.17 B	62.93 B	5.82 A	6.87 A
T4-(T2+Humic acid)	16.84 B	16.60 B	59.47 B	61.94 B	5.92 A	6.75 A
T5- (T2+Magnetic iron)	14.37 C	14.25 C	60.04 B	60.15 B	5.88 A	6.82 A
T6- NPK + Compost (each at 50%)	16.81 B	18.22 B	66.85 A	68.15 A	5.80 A	6.80 A
T7- (T6 + NPK Bio-fert +Mag-Fe +Humic)	16.49 B	18.17 B	66.39 A	68.52 A	5.80 A	6.75 A
T8-(T7 +Bento cid)	18.25 A	20.83 A	66.40 A	70.12 A	5.95 A	6.75 A
T9- (T7 + Amino fert)	17.89 A	19.00 A	66.32 A	69.07 A	5.85 A	6.64 A
T10-(T7 + K-Silicate)	18.01 A	20.53 A	67.53 A	69.43 A	5.91 A	6.77 A

Values within each column followed by the same letter/ s are not significantly different at 5% level.

2. Blooming spurs %:

Data in Table (3) reveal that Blooming spurs % was highly enhanced and reached to the peak value due to the fertilization with NPK in both mineral and organic forms each at 50 % (T6); T6 + bio-fertilizers + humic acid + magnetic iron (T7); T7 coupled with either bento cide (T8) or amino acid (T9) or K-silicate (T10) rather than the other investigated treatments during the 1st and 2nd seasons.

The other five treatments were less effective than the earlier five treatments, and in turn standed the second rank in such evaluation.

3. Number of flowers/spur:

Data of flowers number/spur of Le-Conte pear trees are presented in Table (3). Such data indicate that there were no significant differences among the investigated treatments in relation to the studied parameter during both seasons of study.

Our results are in agreement with those reported by Ismail (2002) and Abdou (2010) on Le-Conte pear trees. They mentioned that average number of spurs/branch and blooming spurs % were maximized with either NPK mineral fertilizer at 100 % level or the combination between organic (compost) fertilizer at 15 kg/tree + bio fertilizer + humic acid. Meanwhile, the least values of such two parameters were detected with those organic fertilized trees at 100 % level without any additive.

Concerning the impact of mineral, organic and bio fertilizer on flowering behavior of some deciduous trees, Fayed (2005) on peach trees, reported that. Farmyard manure at 15 t/ha enhanced flowering, the absence of N fertilization caused an early flowering and the addition of bio fertilizers to organic manure improved the % of bud (floral and vegetative) opening.

In addition, El-Motaium (2007) on apple trees, found that N at 50 or 100 kg/ha induced early flowering associated with decreasing in No. of flower buds.

On the other hand Ashish Yadav Bist (2003) indicated that the application of N from 60 – 100 g/tree reduced the No. of vegetative spurs, whereas the number of floral spurs and No. of flowers/meter of branch (NFPB) increased with the application of N at rates higher than 40 g/tree. The lowest number of vegetative spurs and the highest number of floral spurs and (NFPB) were recorded for 60 g N/tree.

Fruiting aspects:

1. Fruit set %:

Dealing with fruit set % of Le-Conte pear trees as impacted by the investigated soil amendments and foliar growth stimulants, data presented in Table (4) indicate that there were significant differences among the studied treatments. Hence, the highest recognized values of such parameter were associated with those T7 sprayed trees with either bento cide at 5 g/l (T8) or K-silicate at 8.0 ml/l (T10). Furthermore, the trees which received NPK in both inorganic and organic forms each at 50 % level connected with bio fertilizer, humic acid at 5 ml/l and magnetic iron at 500 g/tree (T7) as well as T7 conjoint with amino-fert spray at 2.5 ml/l (T9) stepped up fruit set % better than the other investigated treatments and in turn both treatments (T7 and T9) standed the second rank in this respect.

On the other hand, the worse value of such parameter was recorded with those organic (compost) treated trees at 100 % level (T2), as such treatment was out range of acceptable obtained values.

2. Number of fruits/tree:

Concerning number of fruits/tree, as influenced by the investigated treatments, data tabulated in Table (4) show that enhancement of such parameter was more pronounced with T7 coupled with either bentocide at 5 g/L (T8) or K-silicate at 8.0 ml/l (T10) rather than the other investigated treatments. Furthermore, the sharing fertilization with both inorganic (NPK) and organic (compost) by 50 % of each one (T6); T6 + bio fertilizers + humic acid + magnetic iron (T7) and T7 combined with amino-fert (T9), as those three treatments (T6, T7 and T9) came after and in turn standard the second rank in this respect.

The diminutive value of the investigated parameter was troughed about by organic (compost) at 100 % level as sole fertilizer (T2). Such trend was true during both seasons of study.

3. Yield/tree (kg):

Regarding yield of Le-Conte pear trees as kg/tree in response to the studied soil amendments and foliar growth stimulants, data presented in Table (4) indicate that the trend or the behavior of such parameter in response to the studied treatments was harmonious with No. of fruits/tree

parameter, which has been discussed earlier, except the addition of humic acid (green power) or magnetic iron to organic (compost) fertilizer at 100 % level the less of yield/tree is likely to be i.e., those two substances failed to animate tree yield.

Table 4: Effect of NPK source (mineral &organic), level and their combinations with some stimulants (3 bio NPK fertilizers), magnetic-Fe, K-silicate and (amino/organic acids) on Fruit set %, No. of fruits/tree and yield (kg/tree), of "Le-Conte" pear trees during 2014-2016 and 2015-2017 experimental seasons.

Evaluated parameters	Fruit set (%)		No. of fruits/tree		Yield (kg/tree)	
Seasons / Investigated treatments	2016	2017	2016	2017	2016	2017
T1-Mineral NPK 100% (control)	12.44 C	13.16 C	189.0 C	207.0 C	30.96 C	33.29 C
T2- Compost 100%	08.69 E	09.48 E	164.0 E	175.0 E	23.00 D	26.25 D
T3-(T2+NPK Bio fertilizer)	10.75 D	12.38 D	181.0 C	195.0 C	28.42 C	32.18 C
T4-(T2+Humic acid)	10.40 D	12.16 D	170.0 D	182.0 D	26.26 D	29.57 D
T5- (T2+Magnetic iron)	09.10 D	10.29 D	177.0 D	186.0 D	25.03 D	28.23 D
T6- NPK + Compost (each at 50%)	12.89 C	13.71 C	194.0 B	215.0 B	32.15 B	38.23 B
T7- (T6 + NPK Bio-fert +Mag-Fe +Humic)	13.42 B	14.74 B	198.0 B	222.0 B	33.17 B	39.92 B
T8-(T7 +Bento cid)	14.96 A	16.18 A	219.3 A	245.0 A	38.62 A	44.98 A
T9- (T7 + Amino fert)	13.76 B	14.35 B	203.0 B	225.0 B	34.39 B	40.73 B
T10-(T7 + K-Silicate)	14.54 A	15.87 A	211.0 A	230.0 A	37.68 A	42.61 A

Values within each column followed by the same letter/s are not significantly different at 5% level.

Our findings in response to the relationship between amino acids, nutrients foliar spray and yield of Le-Conte pear trees are in line with those reported by Koksal *et al*., (1999) on pear cv.Williams, Naiema (2008) on Le-Conte pear trees.

On mango trees, application of bio-stimulant containing 5 % free amino acids + 30 % KO2 may be useful to increase fruit set and marketable yield (Morales-Payan 2015). In addition, Kelani (2017) reported that NPK in mineral and organic form by 50 % of each source combined with either 10 or 20 g/l of bento cide reflected the highest value of fruit set % and yield of Fagri Kalan mango trees. On the other hand, the least values of such two parameters were recorded with those 100 % organic fertilized trees.

The obtained data regarding the effect of NPK on yield confirm the findings of Khemira *et al*., (1998) on Doyenne comice pear trees, who found that fruit set was increased by autumn-applied urea. Meanwhile, fruit set, yield and yield increment % in relation to the control of Le-Conte pear trees were significantly increased by the combination between N, P and humic acid (Kabeel *et al*., 2008).The addition of NPK at 90:30:30 not only promoted the highest yield, but also generated the highest benefit-cost and marginal rate of return (Zegbe *et al*., 2014).

Furthermore, Kumar *et al*., (2017) on apple trees indicate that foliar NPK spray along with 62.5 % of NPK recommended dose at foliage sprouting, flowering and fruit set stage resulted in better cropping behavior and fruit yield compared to traditional soil fertilization.

Foliar application of B, K, Zn and Fe as well as NPK soil application increased fruit set and yield of pear trees (Abd El-megeed *et al*., 2013, and Gurel and Basar 2016).

Supplemental nutrition at a rate 90 N: 30 P: 30 K increased pear fruit yield. While the application of K alone had no effect on fruit yield. Therefore, the maximum response of fruit yield was estimated at 30.3 ton/ha with 90 N and 30 P/ha (Zegbe *et al*., 2014).

The same depressive trend of K was found by Brunetto *et al*., (2015) on pear trees. They indicated that yield components and fruit yield was not affected by K fertilization.

On the contrast, foliar application of KNO3 is an effective way to increase "Kousui" Japanese pear fruit yield (Shen *et al*., 2016).

Rathi and Bist (2004) studied the effects of different organic manures and bio fertilizers with or without chemical fertilizer on pear, they found that 10 kg poultry manure + 300: 150: 250

NPK/tree gave the highest yield. In addition, Azotobacter at 30 g + 20 kg organic manure enhanced fruit yield of pear cv. Gola (Hariom Sah Rai and Kumar, 2010).

Our foundations dealing with the relationship between Bio-organic and yield are in line with Abdou (2010); fawzi *et al*., (2010) and Mohamed *et al*., (2010) on Le-Conte pear trees. They found that the application of compost with bio fertilizer gave a better effect on fruit set and yield, while compost alone reflected the lowest values of the two investigated parameters.

Meanwhile, fruit yield of Nanguo pear trees resulting from the combination between mineral and organic fertilizers tending to be most effective (Liu *et al*., 2013).

Fruit characteristics:

A- Fruit physical characteristics:

1. Fruit length (cm):

With respect to fruit length of Le-Conte pear trees as impacted by the different investigated treatments, data presented in Table (5), indicate that the trees which were fertilized with NPK in mineral form combined with organic (compost) each at 50 % (T6); T6 + bio-fertilizers + humic acid at 5 ml/l + magnetic iron at 500 g/tree (T7); T7 + bento cide at 5 g/l (T8); T7 + amino-fert at 2.5 ml/l (T9); T7 + K-silicate at 8.0 ml/l (T10) and NPK in mineral form at 100 % (control), produced longest fruits as compared with the other treatments. Meanwhile, the shortest fruits was associated with those organic (compost) fertilized trees at 100 % level alone (T2) or conjoined with magnetic iron (T5) during both seasons of study. The rest two treatments (T3 and T4) were in between.

2. Fruit diameter (cm):

Data concerning fruit diameter of Le-Conte pear trees are tabulated in Table (5).Those data refer that the behavior of such parameter was nearly closed to fruit length behavior which has been discussed earlier. Hence, T6, T7, T8, T9 and T10 enhanced fruit diameter as those treatments achieved the highest fruit diameter as compared with the other treatments. Furthermore,(T1 control) , T3, T4 and T5 came in the second rank in this respect. On the other hand, the least fruit diameter was observed when organic (compost) fertilizer was used at 100 % level as unique fertilizer (T2).

3. Fruit shape index:

Fruit shape index data of Le-Conte pear trees as responded to the different investigated treatments are presented in Table (5). Such data refer that the fertilization with NPK in mineral form at 100 % level (T1-control); organic (compost) fertilizer at 100 % level (T2); T2 + either bio fertilizer (T3) or humic acid (T4) were able to reflect the highest value of the studied parameter during both seasons of study, as those four treatments produced longest fruits. Meanwhile, the longest fruit value was vacillated between the 1st and the 2nd seasons with respect to the other six treatments.

On the other hand, the least value of such parameter was associated with those organic (compost) fertilized trees at 100 % level combined with magnetic iron foliar spray (T5) during both seasons of study.

Table 5: Effect of NPK source (mineral & organic), level and their combinations with some stimulants (3 bio NPK fertilizers), magnetic-Fe, K-silicate and (amino/organic acids) on fruit length (cm), fruit diameter (cm) and fruit shape index of "Le- Conte" pear trees during 2014-2016 and 2015-2017 experimental seasons**.**

Evaluated parameters	Fruit length (cm)		Fruit diameter (cm)		Fruit shape index	
Seasons / Investigated treatments	2016	2017	2016	2017	2016	2017
T1-Mineral NPK 100% (control)	6.96 A	7.46 A	5.77 B	6.11 B	1.206 A	1.221 A
T2- Compost 100%	6.54 C	6.98 C	5.42 C	5.63 C	1.207 A	1.240 A
T3-(T2+NPK Bio fertilizer)	6.86 B	7.33 B	5.64 B	5.96 B	1.216 A	1.230 A
T4-(T2+Humic acid)	6.83 B	7.26 B	5.59 B	5.95 B	1.222 A	1.220 A
T5- (T2+Magnetic iron)	6.57 C	7.04 C	5.65 B	5.89 B	1.163 C	1.195 C
T6- NPK + Compost (each at 50%)	6.98 A	7.50 A	5.81 A	6.23 A	1.201 A	1.205 B
T7- (T6 + NPK Bio-fert. +Mag-Fe +Humic)	7.04 A	7.52 A	5.83 A	6.22 A	1.208 A	1.208 B
T8-(T7 +Bento cid)	7.09 A	7.61 A	5.96 A	6.23 A	1.190 B	1.222 B
T9- (T7 + Amino fert.)	7.05 A	7.57 A	5.97 A	6.22 A	1.181 B	1.217 B
T10-(T7 + K-Silicate)	7.12 A	7.63 A	6.02 A	6.25 A	1.183 B	1.221 A

Values within each column followed by the same letter/s are not significantly different at 5% level

4. Fruit size (volume) cm^3:

Regarding fruit size (cm^3) of Le-Conte pear trees as influenced by some soil amendments and foliar stimulants, data presented in Table (6) indicate that there were remarkable fruit size variations. Herein, T7 combined with either bento cide (T8) or K-silicate (T10) were the most two promising treatments in enhancing fruit size parameter, as both treatments (T8 and T10) achieved the highest value of such parameter, followed by T7 + amino fert (T8) which ranked the second in this respect. The least significant value of fruit size was recorded with either organic (compost) fertilizer at 100 % level alone (T2) or T2 combined with magnetic iron (T5) during both seasons of study. The responses to the other investigated treatments were in between .

5. Fruit firmness Ib/$inch^2$:

Data dealing with fruit firmness of Le-Conte pear trees are tabulated in Table (6). It is clear from such data that there is a negative relationship between fruit size (volume) and fruit firmness, i.e. the smaller fruit size, the greater fruit texture firmness is likely to be and the opposite is true. Herein, the highly fruit firmness was associated with organic (compost) fertilization at 100 % level alone (T2) and T2 combined with magnetic iron (T5). Meanwhile, the highest softened fruit values were correlative with either T7 conjoined with bento cide (T8) or T7 coupled with K-silicate (T10) during both seasons of study .

6. Fruit weight (g)

The collective and recorded data in Table (6) of fruit weight parameter in response to the different investigated treatments indicate that there were variable responses to the such parameter Hence, the highest predominate values of fruit weight parameter were brought about by both T7 combined with bento cide (T8) and T7 conjoined with K-silicate (T10) as both treatments (T8 and T10) maximized fruit weight values. Meanwhile, the following four treatments T7 + amino-fert (T9); T6 + bio fertilizers + humic acid + magnetic iron (T7); (T6) and (T1) control came in the second rank in this respect.

On the other hand, the reverse was true with the fertilization with organic (compost) fertilizer at 100 % level (T2) alone or T2 combined with magnetic iron (T5), as both treatments minimized the investigated parameter, during both seasons of stud.

Table 6: Effect of NPK source (mineral & organic), level and their combinations with some stimulants (3 bio NPK fertilizers, magnetic-Fe, K-silicate and (amino/organic acids) on fruit weight (g), fruit size (cm^3) and fruit firmness lb/inch2 of "Le-Conte" pear trees during 2014-2016 and 2015-2017 experimental seasons.

Evaluated parameters	Fruit weight (g)		Fruit size (cm^3)		Fruit firmness (L/inch2)	
Seasons / Investigated treatments	2016	2017	2016	2017	2016	2017
T1-Mineral NPK 100% (control)	163.8 B	160.8 C	165.0 C	177.0 C	17.85 C	18.01 C
T2- Compost 100%	140.3 D	150.0 D	141.4 E	151.3 E	20.85 A	21.49 A
T3-(T2+NPK Bio fertilizer)	157.0 C	165.0 C	158.2 D	166.9 D	19.01 B	19.85 B
T4-(T2+Humic acid)	154.5 C	162.2 C	155.7 D	163.4 D	18.89 B	18.96 B
T5- (T2+Magnetic iron)	141.4 D	151.8 D	142.6 E	153.1 E	20.65 A	21.36 A
T6- NPK + Compost (each at 50%)	165.7 B	177.8 B	167.1 C	178.9 C	17.08 C	18.10 C
T7- (T6 + NPK Bio-fert +Mag-Fe +Humic)	167.5 B	179.8 B	168.8 C	180.9 C	17.08 C	18.19 C
T8-(T7 +Bento cid)	167.1 A	183.6 A	177.3 A	184.9 A	15.65 E	16.44 E
T9- (T7 + Amino fert)	169.4 B	181.0 A	170.8 B	182.0 B	16.38 D	17.65 D
T10-(T7 + K-Silicate)	178.6 A	184.7 A	179.4 A	185.9 A	15.85 E	16.53 E

Values within each column followed by the same letter/s are not significantly different at 5% level.

B- Fruit chemical properties

1. Fruit pulp juice total soluble solids (TSS %)

Regarding TSS of Le-Conte pear trees as impacted by the different investigated treatments, data presented in Table (7) indicate that the response was fluctuated along the treatments. Herein, the highest TSS % enhancement was resgitrated with the combination between NPK in mineral and organic forms each at 50 % (T6); T6 + humic acid + bio fertilizers + magnetic iron (T7); T7+ bento cide (T8); T7 + amino fert (T9) and T7 + K-silicate (T10 .(

In addition, NPK in mineral form (T1-control) at 100 % level and NPK in organic (compost) form at 100 % conjoined with bio fertilizers (T3) were less effective in this respect and in turn, both treatments (control – T1) and T3 came in the second rank in this respect during both seasons of study.

On the other hand, the reverse was true with the fertilization with NPK in organic (compost) form at 100 % level (T2) alone; as such treatment minimized the studied parameter to the least value .

2. Fruit flesh total titratable acidity:%

Data concerning the relationship between fruit flesh acidity % and the applied treatments are presented in Table (7). Such data reveal that the fertilization with either NPK in mineral form (T1-control) at 100 % level alone or NPK in organic (compost) form at 100 % level (T2) alone encouraged fruit acidity production to reach its highest level. Meanwhile, the reverse was true with those T7 attributed with K-silicate (T10) treated trees, as such treatment was able to decrease fruit acidity % to the minimum level, during both seasons of study. The other seven investigated treatments were in between .

3.TSS/acid ratio:

The calculated TSS/acid ratio, data of Le-Conte pear fruits are presented in Table (7). Such data confirm that T7 + bento cide (T8); T7 + amino fert (T9) and T7 + K-silicate (T10) achieved the highest values of TSS/acid ratio i.e. the flesh taste of such fruits is more sweetness. Furthermore,

the fertilization with NPK in mineral and organic form each at 50 % level (T6) and T6 + bio fertilizers + humic acid + magnetic iron (T7) represented the second category in this respect. The third category is resembled by NPK mineral fertilization at 100 % level (control-T1); NPK in organic form at 100 % level T2 combined with either bio fertilizers (T3) or humic acid (T4) or magnetic iron (T5).

On the other hand, the least value of TSS/acid ratio was recorded when the trees were organic fertilized at 100 % level alone (T2) during both seasons of study.

Table 7: Effect of NPK source (mineral & organic), level and their combinations with some stimulants (3 bio NPK fertilizers), magnetic-Fe, K-silicate and (amino/organic acids) on TSS (%), fruit acidity and TSS/acid ratio of "Le-Conte" pear trees during 2014-2016 and 2015-2017 experimental seasons**.**

Evaluated parameters	TSS (%)		Fruit acidity (%)		TSS/acid ratio	
Seasons / Investigated treatments	2016	2017	2016	2017	2016	2017
T1-Mineral NPK 100% (control)	14.17 B	13.40 B	0.262 A	0.272 A	54.00 C	49.26 C
T2- Compost 100%	12.90 D	12.83 D	0.262 A	0.271 A	49.42 D	47.34 D
T3-(T2+NPK Bio fertilizer)	13.69 B	13.71 B	0.248 B	0.262 B	55.20 C	52.73 C
T4-(T2+Humic acid)	13.54 C	13.12 C	0.245 B	0.258 B	55.27 C	50.85 C
T5- (T2+Magnetic iron)	13.08 C	13.12 C	0.242 B	0.256 B	54.05 C	51.25 C
T6- NPK + Compost (each at 50%)	14.27 A	14.69 A	0.247 B	0.255 B	57.77 B	57.61 B
T7- (T6 + NPK Bio-fert. +Mag-Fe +Humic)	14.36 A	14.47 A	0.241 B	0.250 B	59.59 B	57.88 B
T8-(T7 +Bento cid)	14.75 A	14.78 A	0.236 B	0.248 B	61.74 A	59.60 A
T9- (T7 + Amino fert.)	14.49 A	14.50 A	0.239 B	0.247 B	60.63 A	58.70 A
T10-(T7 + K-Silicate)	14.86 A	14.80 A	0.234 C	0.226 C	63.50 A	65.49 A

Values within each column followed by the same letter/s are not significantly different at 5% level

4. Fruit pulp sugar content %:

Le-Conte fruit pulp sugar content in relation to the studied treatments was determined and the collective data are presented in Table (8). Such data obviously clear that the combination between NPK in mineral and organic (compost) fertilizers for each at 50 % level either in the absence of any additives (T6) or with bio fertilizers + humic acid + magnetic iron (T7) or T7 + bento cide (T8) or T7 + amino fert (T9) or T7 + K-silicate (T10) were the most five pronouncing treatments, as those treatments maximized the studied parameter during both seasons of study.

On the other hand, the least value of fruit sugar content was recorded when the trees were fertilized with organic (compost) fertilizer at 100 % level alone (T2). The other four treatments including control treatment were intermediate during both seasons of study.

5. Vitamin "C" content:

Data of vitamin C content of fruit pulp juice are tabulated in Table (8). Such data indicate that NPK application in both mineral and organic forms together or such combination coupled with soil amendments or growth stimulants, the greatest V. C content is likely to be.

There are two response categories could be distinguished: the first resembled by NPK in mineral form at 50 % level + NPK in organic form at 50 % level (T6); T6 + bio fertilizers + humic acid + magnetic iron (T7); T6 + bento cide (T8); T6 + amino fert (T9) and T6 + K-silicate (T10). Those five treatments maximized the studied parameter. The second trend was associated with NPK mineral form at 100 % level (control-T1); T2 + bio fertilizers (T3); T2 + humic acid (T4) and T2 + magnetic iron (T5). Those four treatments came after in this respect and subsequently, arranged in the second rank, during both seasons of study.

On the other hand, the least value of the investigated parameter was registered with organic (compost) fertilizer at 100 % level of NPK (T2). Such trend was true during both seasons of study.

Table 8: Effect of NPK source (mineral & organic), level and their combinations with some stimulants (3 bio NPK fertilizers), magnetic-Fe, K-silicate and (amino/organic acids) on total fruit sugar % and Vitamin (C) mg/100g of "Le-Conte" pear trees during 2014-2016 and 2015-2017 experimental seasons**.**

Evaluated parameters	Total fruit sugar (%)		Vitamin (C) (mg/100g)	
Seasons / Investigated treatments	2016	2017	2016	2017
T1-Mineral NPK 100% (control)	11.66 B	11.21 B	2.67 B	2.76 B
T2- Compost 100%	10.18 C	10.01 C	2.29 C	2.31 C
T3-(T2+NPK Bio fertilizer)	11.65 B	11.29 B	2.59 B	2.78 B
T4-(T2+Humic acid)	11.61 B	11.34 B	2.55 B	2.72 B
T5- (T2+Magnetic iron)	11.46 B	11.41 B	2.50 B	2.63 B
T6- NPK + Compost (each at 50%)	12.15 A	12.51 A	2.94 A	3.11 A
T7- (T6 + NPK Bio-fert. +Mag-Fe +Humic)	12.12 A	12.63 A	3.17 A	3.28 A
T8-(T7 +Bento cid)	12.08 A	12.68 A	3.13 A	3.29 A
T9- (T7 + Amino fert.)	12.03 A	12.89 A	2.98 A	3.27 A
T10-(T7 + K-Silicate)	12.11 A	12.42 A	2.99 A	3.36 A

Values within each column followed by the same letter/s are not significantly different at 5% level

The obtained data dealing with the impact of amino acids on fruit quality are in harmony with those stated by Kokasl *et al*. (1999); Naiema (2008) and Liu *et al*. (2012). They suggested that compost + amino acid fertilizer or Aminofert (20 % amino acids + 12 % organic acids and 3.6 % chelated microelements) was more effective in improving fruit pear physical and chemical qualities (fruit size, firmness, TSS, fructose, glucose, sucrose, flavors).

Spray liquid fertilizer (humic acid + N, P, K, Ca, Mg, S and micronutrients) increased fruit size by 21.8-29.2 % and TSS by 1.6-2.4 % of Huahua pear trees (Zhu 2000).

Hudina (2004) and Hudina and Stampar (2005) reported that foliar fertilizer (15 % P, 20 % K, 0.1 % Mn, 0.1 % B and 0.1 Mo increased fruit size, diameter, length, weight, TSS, sugars and organic acids (malic, citric) of P. communis cv. Williams.

Duarte *et al*., (2010) found that pulp firmness, TSS and acidity were within the adequate range values when pear trees cv. Rocha were sprayed with N at 43 kg/h, and K2O at 20 kg/ha.

Pear fruit quality determined as fruit firmness, peel and pulp ratio and TSS exhibited inconsistent response to NPK mineral nutrition (Zegbe *et al*., 2014).

On the contrast, N rate did not significantly affect the contents of total soluble solids, ascorbic acid and total sugars on pear trees, while acidity decreased when N was used from 70 to 90 g N/tree Ashish Yadav Bist (2003).

K-promoted sugar accumulation of the leaves and fruit might result from up-regulated expression levels of key genes involved in sugar metabolism by K in leaves and fruit. K accumulation and concentration in leaves and fruit with the net photosynthetic rate and SPAD value of leaves found to increase with the increase of K application rate Wang *et al*., (2017).

Likewise, K role and its effects have been gotten earlier by Gill *et al*., (2012) who reported that foliar K application (KNO3 and KSO4 at 1.5 and 2 % once, two and three sprays) improved pear fruit size (maximum fruit size was recorded with KNO3 at 1.5 %), fruit colour (K2SO4 was found more effective), fruit firmness and TSS increased with both higher dose of K.

Considering bio-organic fertilizer our results are confirmed by Limin *et al*., (2014); Muniz *et al*., (2015) and Dou (2017) on pear trees.

Recommendation

It could be concluded that fertilization with NPK in mineral form + NPK in organic form (compost) each at 50% combined with some soil stimulants, bio fertilizers (Phosphorene, Nitrobein, Potassien at 30g/tree) + humic acid at 5ml/L + magnetic iron at 500g/tree associated with spraying with either some nutritional compounds bentocide at 5g/L or amino fert at 2.5 ml/L or K-silicate at 8.0 ml/L, could improve growth, flowering, fruiting and fruit quality attributes of pear trees cv. "Le-Conte" grown under El-Kassasien, Ismailia Governorate conditions.

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