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EFFECT OF BIO-STIMULANT AND SOIL AMENDMENT ON VEGETATIVE GROWTH, YIELD AND FRUIT QUALITY OF *Pyrus communis* cv. 'LE CONTE' PEAR TREES.

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ABSTRACT

The experimental trial was consummated throughout two successive seasons (2012 and 2013) at a commercial orchard at El-Khatatba city, Monifia Governorate, Egypt. It intended to find out the possibility of enhancing "Le Conte" pear trees productivity under local condition in the newly reclaimed lands. Thus, the individual and combined applications of bio-stimulant (EM) and soil amendment (NPK humate) applied as soil drench fourteen times at 2 weeks intervals commencing from first February till mid August to study their effect on vegetative growth, nutrient availability, yield and fruit quality of "Le Conte" pear trees. Results indicated that combined applications of bio-stimulant (EM) and soil amendment (NPK humate) were better than the individual applications, especially at the rate of 200 cm^3 EM + 75 cm^3 NPK humate/tree/year which showed the best significant effect on various estimated parameters under this study during both seasons.

Keywords: Effective microorganisms, Leaf mineral contents, NPK humate, pear, Soil nutrients, Pome fruit.

INTRODUCTION

'Le Conte' pear is one of the deciduous fruits successfully grown in the newly reclaimed lands as in Egypt. These lands faces many problems such as an excess of $CaCo_3$ and high pH value (Table 1) which cause unavailability of most nutrients to the plants. Moreover, soil properties such as: water holding capacity, cation exchange capacity, bulk density, and soil fertility which directly affect plant development are poor in this type of soil. In this case soil fertility can be improved by the addition of bio-stimulants like effective microorganisms (EM) or soil amendment like NPK humate to satisfy the needs of plant from such elements since good growth is mostly associated with good yield.

Bio-stimulants have been described as “non-nutritional products that may reduce fertilizer use and increase yield and resistance to water and temperature stresses ” which have been shown to increase plant shoot and root growth, and uptake of some nutrients (Russo & Berlyn, 1992 and Poincelot, 1993). One of these bio-stimulants is EM which created in Japan over 25 years ago in University of the Ryukyus in Okinawa and marketed by EMRO (EM Research Organization). The basic purpose of EM is the restoration of healthy ecosystem in both soil and water by using three major genera of microorganisms which are found in nature: phototrophic bacteria (Rhodopseudomonas), lactic acid bacteria (Lactobacillus) and yeast (Saccharomyces) (Higa 1998 and Abd-Rabou, 2006).

Many authors documented favorable effects of using EM as bio-stimulant on growth and yield of several crops. In this respect Sangakkara (1999) stated that EM improved nutrient uptake efficiency, enhanced root growth and increased yield; also, it was able to improve the yield of Kelsey plum (Eissa, 2003).

Soil amendments including organic materials, synthetic chemical fertilizers, or humate-based products which aid plant establishment by providing for a rooting environment from the improvement of soil structure, aeration, water retention, and nutrient availability (Wager, 1982; Corley, 1984 and Autio & Greene, 1991). A differentiate on the effects of commercial products containing humic acid, including NPK-humate should be made between indirect and direct effects on plants growth. Indirect effects are mainly undertaken through properties such as: enrichment in soil nutrients, increase of microbial population, higher cation exchange capacity (CEC), improvement of soil structure; whereas direct effects are various biochemical actions exerted at the cell wall, membrane or cytoplasm and mainly of hormonal nature (Varanini & Pinton, 2001 and Chen *et al.,* 2004).

Using commercial products containing humic acid in pear production are very rarely reported in the literature, but some investigations have been conducted with these products in different fruits like orange and grapefruit (Alva and Obreza, 1998), lemon (Sànchez-Sànchez *et al.,* 2002), apple (Neilsen *et al,.* 2005) and date palm (Elboray *et al.*, 2006).

Actually, responses of pear trees to the drench application of bio-stimulant (EM) and soil amendment (NPK humate) are still limited. Thus, the main objective of this work was to improve the growth of pear trees, crop yield and fruit quality in the newly reclaimed lands without adversely affecting the environment by increasing dependence on bio-stimulants and soil amendments in pear production**.**

MATERIALS AND METHODS

Plant materials and experimental procedure:

The present experiment was conducted throughout two successive seasons (2012 and 2013) at a commercial orchard at El-Khatatba city, Monifia Governorate, Egypt to study the effect of bio-stimulant (EM) and soil amendment (NPK humate) as soil drench on the productivity and fruit quality of "Le Conte" pear trees under the newly reclaimed lands conditions. These trees were fifteen years old, budded on *Pyrus communis* rootstock, spaced at 5 meters apart grown in sandy loam soil under drip irrigation system and trained with modified central leader which were similar in their vigor, as possible and treated with common agricultural practices in both seasons.

Prior to executing the experiment, the soil's physical and chemical properties of the experimental site were determined as follow:

The electrical conductivities of the 1:5 soil paste extracts were measured by EC meter according to the method of US SALINITY LAB (1954). Soil reaction (pH) was measured in 1:2.5 soil water suspension as described by Jackson (1973). Mechanical analysis was determined following the international pipette method (Kilmer and Alexander, 1949), using NH_4OH as a depressing agent. Calcium carbonate was determined using Collin's calcimeter method (Piper, 1950). Organic matter content was determined using Walkely's rapid titration method (Jacson, 1973). Available NPK was determined according to the methods of Chapman and Pratt (1982). And the results of this analysis are presented in Table (1).

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

Soil depth	Mechanical Analyses %					Chemical Analyses								
						(meq/100g soil)						Available (ppm)		
	Texture	pH 1:2.5	E.C 1:5 ds/m	Total $CaCO_3$	O.M %	Ca^{++}	Mg^{++}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{--}	N	P	K
0 - 30	Sandy loam	7.96	1.3	3.91	0.88	2.78	1.05	0.09	1.23	2.39	3.01	39.9	4.2	363.3
30-60	Sandy loam	7.88	1.1	2.15	0.61	2.34	0.85	0.12	1.08	1.82	2.74	35.5	3.6	335.7

EM is a commercial bio-stimulant, produced by EMRO corporation, Okinawa, Japan, and contains more than 60 selected strains of "effective microorganisms" (photosynthetic bacteria, lactic acid bacteria, yeast, actinomycetes and various fungi) and NPK humate is an soil amendment produced by Horticultural Research Institute in Egypt and it consists of 8% N, 8% P_2O_5, 8% K_2O and 10% humate.

Seventy two trees were selected for the purpose of this experiment which was designed as a completely randomized blocks design with four replicates (two trees for each replicate) to represent the individual and combined treatments with EM and NPK humate during the two seasons as follows:

T1 150 cm^3 EM/tree/year.
T2 200 cm^3 EM/tree/year.
T3 75 cm^3 NPK humate /tree /year.
T4 100 cm^3 NPK humate /tree/year.
T5 150 cm^3 EM + 75 cm^3 NPK humate/tree/year.
T6 150 cm^3 EM + 100 cm^3 NPK humate/tree/year.
T7 200 cm^3 EM + 75 cm^3 NPK humate/tree/year.
T8 200 cm^3 EM + 100 cm^3 NPK humate/tree/year.
T9 Control.

These quantities were divided into fourteen equal doses and added in the soil at two weeks intervals from the beginning of February till mid of August, during both seasons. All the individual and combined EM and NPK humate treatments were applied in circle around the tree trunk beneath the canopy (50 cm away from the tree trunk) and were incorporated into the top 20 cm layer of soil by mixing with 10 L irrigation water.

Vegetative Growth Measurements:

In each growing season, four main branches as uniform as possible were chosen at the four cardinal points of each experimented tree and the average lengths and diameters of the current shoots per selected branches were measured in (cm) at the end of August, in both seasons. Furthermore, samples of 20 mature leaves from each replicate were taken at the same time from the middle of the current growing shoots per selected branches to measure the average leaf area in cm^2 by using leaf area meter (GI- 203 AREA METER CID, Inc. USA).

Leaf mineral contents:

The contents of N, P, K, Fe, Zn and Mn in mature leaves were determined after two weeks from the last addition in the two seasons of study. Samples of 30 mature leaves were taken from the middle of the current growing shoots per selected branches of each tree. Leaf samples were washed with tap water, rinsed twice in distilled water, oven dried at 70 ^{o}C till a constant weight and then grinded. Macro nutrient was determined according to the method described by Jones (2001) by using micro-kjeldahl for determining total nitrogen percentage, chorotannus-reduse molybdo phosphoric blue color method in sulphoric system for determining phosphorus percentage which estimated calorimetrically and for determining potassium percentage, flame photometer was used. Total Fe, Zn and Mn were estimated using atomic absorption spectrophotometer (A Perkin-Elmer, Model 2380.USA) according to the methods of Chapman and Pratt (1982).

Available macro and micro nutrient in soil:

N, P, K, Fe, Zn and Mn were determined in samples collected randomly after two weeks from the last addition of treatments in the two seasons of study from three sites around each tree according to the methods of Chapman and Pratt (1982).

Yield and fruit quality:

Average yield per each treatment was recorded as kg fruits per tree by counting number of fruits per tree multiplied by average fruit weight. Average yield per feddan was estimated by multiplying yield per tree by the number of trees per feddan in tons at harvesting date. Samples of 10 'Le Conte' pear fruits were harvested at approximately 135 to 147 days from full bloom from each replicate tree randomly, when the average of fruit firmness reached about 14-15 Ib/$inch^2$ according to Swindeman (2002) and when soluble solids in fruits juice reached about 13-14 % for determining fruit quality which described as physical and chemical characteristics as follows:

Physical fruit characteristics:

Fruit size was measured by using the volume of water as cm^3 after dipping fruit in water. Fruit length and diameter were measured by using a vernier calipers as cm; whereas, fruit diameter was measured from the middle of the fruit. Fruit firmness was measured by using a hand Effegi-Penetrometers supplemented with plunger 8 mm diameter and the average was estimated as $Ib.in^{-2}$ (Harker *et al.,* 1996).

Chemical fruit characteristics:

A hand refractometer was used to determine the soluble solids content **(SSC)** in fruit juice (AOAC, 1980). Total titratable acidity was determined in fruit juice by titration with 0.1 N sodium hydroxide and calculated as malic acid according to the method described in AOAC (1980). SSC/acid ratio was expressed by the ratio between SS content and total titratable acidity. Total sugars were determined by using phenol 18% and sulphoric acid 96% and the absorbance was recorded with spectrophotometer at 490 nm, according to the method described by Sadasivam and Manickam (1996).

Statistical analysis:

The obtained data were statistically analyzed as a randomized complete block design with four replicates by analysis of variance (ANOVA) according to the procedure outlined by Snedecor and Cochran (1994), using the statistical package software SAS (SAS Institute Inc. Cary, NC, USA). Comparisons between means were made by using the newly least significant differences test (NLSD) at 5% level of probability as mentioned by Waller and Duncan (1969).

RESULTS AND DISCUSSION

In the newly reclaimed lands high pH and low soil moisture contents are the main environmental factors, impairing nutrient mobility in soil and root extension growth; furthermore, both the total amount of soil nutrients and their availability to plants are therefore closely related to the soil organic matter content and conditions of mineralization (soil moisture, temperature, aeration).

Vegetative Growth:

Data presented in Table (2) clearly showed that combined applications of EM and NPK humate had a significant effect on all the vegetative growth parameters compared to the individual applications of them or control treatment. It was clear that the highest values for leaf area, shoot length and shoot diameter were achieved when the soil around trees was drenched by 200 cm^3 EM combined with 75 cm^3 NPK humate/tree/year while the lowest values for these parameters were obtained by the control in the two studied seasons.

Table 2: Effect of individual and combined applications of EM and NPK humate on vegetative growth during 2012 and 2013 seasons.

Treatment/tree/year	Leaf area (cm^2)		Shoot length (cm)		Shoot diameter (cm)	
	2012	2013	2012	2013	2012	2013
150 cm^3 EM	28.70	29.10	47.25	49.29	0.38	0.40
200 cm^3 EM	31.59	33.05	50.50	54.62	0.40	0.44
75 cm^3 NPK humate	29.84	30.32	49.71	50.33	0.38	0.42
100 cm^3 NPK humate	33.42	34.98	50.63	58.25	0.40	0.44
150 cm^3 EM + 75 cm^3 NPK humate	37.47	38.12	60.75	62.99	0.45	0.52
150 cm^3 EM + 100 cm^3 NPK humate	33.50	34.56	58.13	58.71	0.42	0.46
200 cm^3 EM + 75 cm^3 NPK humate	41.79	42.40	62.00	68.23	0.47	0.54
200 cm^3 EM + 100 cm^3 NPK humate	35.42	37.82	58.25	59.34	0.42	0.50
Control	22.96	24.40	34.50	38.50	0.37	0.38
NLSD at 5%	2.41	3.16	14.78	4.02	0.16	0.04

This might be due to that NPK humate increases nutrients uptake such as N, Ca, P, K, Mg, Fe, Zn and Cu (Adani *et al.,* 1998) or enhances photosynthesis, chlorophyll density and plant root respiration which resulted in greater plant growth (Chen and Aviad, 1990). Also, the humic substances can affect plant physiology and stimulate growth due to their hormone like activity; hence, they have cytokinin and auxin like activity100 and 10 times lower than that of benzyladenine and indol acetic acid, respectively (Pizzeghello *et al.,* 2002).

Furthermore, the enhancement of plant growth by the EM bio-stimulant may be attributed to the profound effect of plant growth regulation substances produced by the effective microorganisms (bacteria, yeast and fungi) or in improving the availability and acquisition of nutrients from the soil which promoted the vegetative growth (Sahain *et al.,* 2007); hence, the bacteria produced adequate amount of IAA and cytokinins which increased the surface area per unit root length and hence enhanced the root hair branching with an eventual increase in acquisition of nutrients from the soil (Jagnow, 1991). These results are in same direction with that of Eissa (2003) on "kelsey" plum and Obreza *et al.* (2009) on citrus trees.

Leaf mineral contents:

Both of bio-stimulant and soil amendment clearly increased leaves content of macro-nutrients (nitrogen, phosphorus and potassium) compared to the control (Table 3).

Table 3: Effect of individual and combined applications of EM and NPK humate on Leaf macro nutrient contents during 2012 and 2013 seasons.

Treatment/tree/year	Leaves					
	N %		P %		K %	
	2012	2013	2012	2013	2012	2013
150 cm^3 EM	1.76	1.80	0.119	0.122	1.25	1.29
200 cm^3 EM	1.85	1.86	0.140	0.145	1.40	1.42
75 cm^3 NPK humate	1.82	1.84	0.131	0.133	1.30	1.31
100 cm^3 NPK humate	1.91	1.92	0.150	0.153	1.47	1.49
150 cm^3 EM + 75 cm^3 NPK humate	1.98	2.00	0.183	0.187	1.70	1.71
150 cm^3 EM + 100 cm^3 NPK humate	1.93	1.94	0.162	0.166	1.50	1.56
200 cm^3 EM + 75 cm^3 NPK humate	2.04	2.05	0.190	0.196	1.78	1.82
200 cm^3 EM + 100 cm^3 NPK humate	1.94	1.95	0.169	0.175	1.60	1.64
Control	1.73	1.75	0.116	0.119	1.09	1.20
NLSD at 5%	0.02	0.02	0.002	0.002	0.02	0.02

Combined application of EM and NPK humate at 200 cm^3 EM + 75 cm^3 NPK humate/tree/year followed by 150 cm^3 EM + 75 cm^3 NPK humate/tree/year had the most pronounced effect on percentages of N, P and K during both seasons compared with the control which presented the lowest values in this respect. Moreover, results for the leaves content of micro-nutrients (Fe, Zn and Mn) has adopted the same approach to the results of the macro-nutrients during both seasons; therefore, trees drenched with 200 cm3 EM + 75 cm^3 NPK humate/tree/year presented the highest significant effect in this respect compared with the other treatments; conversely, control trees gave the lowest leaves content of micro-nutrients during the both seasons of study (Table 4).

Such increase in the micro and macro nutrient in leaves (Table 3 and 4) might be due to an effect caused by increasing nutrient uptake; as a result, drenching soil around pear trees with combined application of EM and NPK humate at 200 cm3 EM + 75 cm3 NPK humate/tree/year lead to an increase in nutrient availability and that coincides with results obtained by Shaddad *et al.* (2005) who showed that 'Canino' apricot leaves contained more N, P and K nutrients as a result of soil application of humic acid and these results were also in line with those reported by Farag (2006) on grapes.

Table 4: Effect of individual and combined applications of EM and NPK humate on Leaf micro nutrient contents during 2012 and 2013 seasons.

Treatment/tree/year	Leaves					
	Fe (ppm)		Zn (ppm)		Mn (ppm)	
	2012	2013	2012	2013	2012	2013
150 cm^3 EM	19.80	20.42	16.00	16.50	22.33	22.60
200 cm^3 EM	22.80	23.27	17.33	18.10	24.10	24.70
75 cm^3 NPK humate	21.70	22.00	17.13	17.30	23.50	24.00
100 cm^3 NPK humate	25.10	25.90	18.50	18.70	24.90	25.33
150 cm^3 EM + 75 cm^3 NPK humate	31.90	32.70	20.70	20.90	28.30	28.80
150 cm^3 EM + 100 cm^3 NPK humate	28.33	29.53	19.00	19.50	26.60	27.00
200 cm^3 EM + 75 cm^3 NPK humate	34.20	35.40	21.20	21.60	29.40	29.60
200 cm^3 EM + 100 cm^3 NPK humate	30.00	30.30	19.90	20.30	27.20	27.60
Control	17.90	18.20	16.00	16.50	21.20	21.50
NLSD at 5%	0.25	0.29	0.25	0.27	0.29	0.30

In addition, Eissa *et al.* (2007) illustrated that humic acid substances promoted pear trees to grow better and accumulate higher amounts of NPK and dry matter. That is may be due to the positive role of humate in enhancing the absorption and translocation of minerals due to its effect on enhancing metabolism (Sivakumar and Devarajan, 2005) and by increasing the permeability of membranes of the root cells (Valdrighi *et al.*, 1996). Also, Abd El-Messeih *et al.* (2005) reported that EM treatments of Le Conte pear trees had significantly increased leaf mineral values of N, P, K, Fe, Zn and Mn as compared to the untreated trees and that could be related to the role of the effective micro-organisms in improving the availability of nutrients and to the modifications of root growth, morphology and /or physiology through hormonal exudates of biofertilizers bacteria resulting in more efficient absorption of available nutrients (Jagnow *et al.*, 1991).

Available Macro and Micro nutrients in soil:

The highest available N, P and K were (88.50 & 90.20 ppm for N, 10.60 & 11.07 ppm for P and 619.00 & 622.00 ppm for K in the two seasons, respectively) observed by drenching soil with 200 cm^3 EM + 75 cm^3 NPK humate/tree/year; on the contrary, the lowest available N, P and K were (62.30 & 62.30 ppm for N, 5.60 & 5.80 ppm for P and 327.0 & 337.0 ppm for K in the two seasons, respectively) occurred with control (Table 5).

Referring to individual and combined effect of EM and NPK humate on available Fe, Zn and Mn in soil, data of Table (6) showed that soil drenched with 200 cm^3 EM + 75 cm^3 NPK humate/tree/year, presented the highest significant effect in this respect; hence, it resulted in 19.70 & 20.80 ppm for Fe, 9.00 & 10.10 ppm for Zn and 13.60 & 14.70 ppm for Mn in the two seasons, respectively. Reversely, the control trees gave the lowest available Fe, Zn and Mn in soil during both seasons.

Table 5: Effect of individual and combined applications of EM and NPK humate on available macro nutrient in soil during 2012 and 2013 seasons.

Treatment/tree/year	Soil					
	N (ppm)		P (ppm)		K (ppm)	
	2012	2013	2012	2013	2012	2013
150 cm^3 EM	66.10	67.10	6.10	6.70	373.33	383.33
200 cm^3 EM	72.40	73.40	7.70	7.90	454.00	464.00
75 cm^3 NPK humate	67.60	68.60	7.23	7.50	418.00	428.00
100 cm^3 NPK humate	77.00	78.00	8.40	8.60	486.00	496.00
150 cm^3 EM + 75 cm^3 NPK humate	84.90	85.47	9.90	10.17	582.00	587.00
150 cm^3 EM + 100 cm^3 NPK humate	79.17	80.13	9.00	9.20	521.00	523.33
200 cm^3 EM + 75 cm^3 NPK humate	88.50	90.20	10.60	11.07	619.00	622.00
200 cm^3 EM + 100 cm^3 NPK humate	87.00	90.43	9.33	9.60	555.66	562.00
Control	62.30	63.30	5.60	5.80	327.00	337.00
NLSD at 5%	2.68	0.37	0.29	0.31	3.46	3.35

These findings are in accordance with Sànchez-Sànchez *et al.* (2006) who stated that humic substance was more effective in increasing Fe uptake in table grape. This could be attributed to the role of humic substances in improving root growth and enhancing the sandy soil's ability to retain and not leach out vital plant nutrients (Gulshan and Singh, 2006).

Regarding to the effect of EM on available macro and micro elements in soil, Abd El-Messeih *et al.* (2005) reported that the EM treatments of Le Conte pear trees had significantly increased some macro and micro elements i.e.(N, P, K, Fe, Zn and Mn) in soil as compared to control and that was in agreement with the results obtained by Abd El-Samad *et al.* (2006) on "Valencia " orange and Al-Ashkar *et al.* (2007) on banana.

Table 6: Effect of individual and combined applications of EM and NPK humate on available micro nutrient in soil during 2012 and 2013 seasons.

Treatment/tree/year	Soil					
	Fe (ppm)		Zn (ppm)		Mn (ppm)	
	2012	2013	2012	2013	2012	2013
150 cm^3 EM	12.50	13.60	4.10	5.20	7.50	8.60
200 cm^3 EM	14.80	15.90	5.40	6.50	8.70	9.80
75 cm^3 NPK humate	13.90	15.00	4.80	5.87	8.10	9.20
100 cm^3 NPK humate	16.60	17.70	6.30	7.40	9.80	10.90
150 cm^3 EM + 75 cm^3 NPK humate	18.80	19.90	8.10	9.20	12.90	14.00
150 cm^3 EM + 100 cm^3 NPK humate	17.50	18.60	6.80	7.90	10.40	11.50
200 cm^3 EM + 75 cm^3 NPK humate	19.70	20.80	9.00	10.10	13.60	14.70
200 cm^3 EM + 100 cm^3 NPK humate	18.10	19.20	7.40	8.50	12.00	13.10
Control	11.40	12.50	3.60	4.70	7.10	8.20
NLSD at 5%	0.30	0.45	0.30	0.44	0.30	0.45

Yield and fruit quality:

The application of EM and NPK humate either singly or in combinations caused significant increase in yield and fruit quality. In particular, the treatment with 200 cm^3 EM + 75 cm^3 NPK humate/tree/year significantly increased number and weight of fruits and yield with respect to the control (Table 7).

Table 7: Effect of individual and combined applications of EM and NPK humate on fruit number and weight and yield during 2012 and 2013 seasons.

Treatment/tree/year	Fruit number/tree		Fruit weight (g)		Yield/tree (Kg)		Yield/feddan (ton)	
	2012	2013	2012	2013	2012	2013	2012	2013
150 cm^3 EM	315.0	325.0	182.0	187.0	57.34	60.78	9.63	10.21
200 cm^3 EM	345.0	355.0	196.0	201.0	67.63	71.36	11.36	11.99
75 cm3 NPK humate	335.0	345.0	192.0	197.0	64.33	67.39	10.81	11.32
100 cm^3 NPK humate	370.0	375.0	203.0	207.7	75.12	77.88	12.61	13.08
150 cm^3 EM + 75 cm^3 NPK humate	405.0	410.3	229.3	232.7	92.89	95.48	15.60	16.04
150 cm^3 EM + 100 cm^3 NPK humate	384.7	389.7	212.0	217.0	81.56	84.57	13.70	14.21
200 cm^3 EM + 75 cm^3 NPK humate	415.0	423.3	233.7	238.7	96.98	101.0	16.29	16.97
200 cm^3 EM + 100 cm^3 NPK humate	393.7	398.7	221.0	224.0	87.00	89.31	14.67	15.00
Control	292.0	297.0	172.0	177.0	50.23	52.57	8.44	8.83
NLSD at 5%	6.77	6.56	3.60	3.36	2.73	2.55	0.46	0.43

With regards to the physical fruit characteristics, combined applications of EM and NPK humate were better than individual ones, especially at the rate of 200 cm^3 EM + 75 cm^3 NPK humate/tree/year which induced a significant increase in size, height, diameter and firmness of fruits collected at harvest, but individual applications showed a preference in this respect compared to the control (Table 8).

A similar response of commercial humic substances was referred by Ferrara and Brunetti (2008) and Sánchez-Sánchez *et al.* (2006) who found that the increase in fruit size as a consequence of humate application is probably ascribed to the uptake of mineral nutrients by pear trees which is important in fruit formation and enhances fruit size, but the possible hormone like activity of the humic substances (i.e., auxin-, gibberellin- and cytokinin-like activity) should also be taken into consideration; hence, gibberellin improve fruit firmness due to its role in increasing cell numbers which increase the ratio of cell wall to cell volume in fruit (Southwick *et al.,* 1995).

Table 8: Effect of individual and combined applications of EM and NPK humate on physical fruit characteristics during 2012 and 2013 seasons.

Treatment/tree/year	Fruit size (cm^3)		Fruit height (cm)		Fruit diameter (cm)		Firmness ($lb.in^{-2}$)	
	2012	2013	2012	2013	2012	2013	2012	2013
150 cm^3 EM	187.0	192.0	7.87	8.13	6.42	6.60	13.73	14.00
200 cm^3 EM	207.0	212.0	8.20	8.57	6.72	6.83	14.00	14.15
75 cm^3 NPK humate	200.0	205.0	7.98	8.38	6.58	6.74	13.95	14.06
100 cm^3 NPK humate	215.0	219.6	8.36	8.69	6.84	6.86	14.03	14.34
150 cm^3 EM + 75 cm^3 NPK humate	245.3	248.6	8.88	9.01	7.09	7.18	14.36	14.68
150 cm^3 EM + 100 cm^3 NPK humate	226.0	230.0	8.60	8.82	6.96	7.00	14.15	14.48
200 cm^3 EM + 75 cm^3 NPK humate	250.6	255.6	9.11	9.45	7.32	7.60	14.66	14.85
200 cm^3 EM + 100 cm^3 NPK humate	236.0	239.0	8.75	8.91	6.95	7.01	14.25	14.55
Control	174.0	179.0	7.57	7.79	6.16	6.19	13.25	13.48
NLSD at 5%	3.595	3.25	0.123	0.077	0.081	0.128	0.170	0.061

Response of chemical fruit characteristics to individual and combined applications of EM and NPK humate is shown in Table (9). Data showed that all treatments affected significantly SSC, acidity and SSC/acid ratio of fruit juice and total sugar of pear fruit unless control treatment which introduced the lowest significant effect in this respect; on the other hand, 200 cm^3 EM + 75 cm^3 NPK humate/tree/year treatment had the most pronounced effect on chemical fruit characteristics compared to other treatments during both seasons.

This improvement of chemical fruit characteristics is in agreement with what reported in 'Chardonnay' and 'Barbera' (Vercesi, 2000) and in table grape (Ferrara and Brunetti, 2008) with various commercial humic substances. The increase of SSC and the statistically significant reduction of total acidity are noteworthy results, and NPK humate may be applied in order to enhance uptake of mineral nutrients like potassium which is necessary for basic physiological functions such as formation of sugars and starch, synthesis of proteins, cell division and growth and flavor and color of fruit (Obreza, 2003 and Abbas & Fares, 2008) and the SSC/acid ratio was conveyable trend with fruit content from soluble solid content and acidity.

Moreover, the effect of EM on increasing Le-Conte pear yield and fruit quality might be attributed to the increments on the amounts of metabolites synthesized by the plant which accelerate plant growth and resulted in improving total yield. These results can be explained as the EM biostmulant contains more than 60 selected strains of microorganisms as bacteria, yeast, actinomycetes and various fungi. The high contents of minerals and vitamins as well as the cytokinins contents in yeast might play a role in orientation and translocation of metabolites from leaves into the productive organs as recorded by Attala (2000). Also, similar results were recorded by Daly and Stewert (1999).

Table 9: Effect of individual and combined applications of EM and NPK humate on chemical fruit characteristics during 2012 and 2013 seasons.

Treatment/tree/year	SSC%		Acidity%		SSC/acidity		Total sugar (mg/g)	
	2012	2013	2012	2013	2012	2013	2012	2013
150 cm^3 EM	13.27	13.60	0.288	0.281	46.06	48.43	7.20	7.40
200 cm^3 EM	13.75	13.90	0.281	0.261	48.95	53.26	7.39	7.51
75 cm^3 NPK humate	13.50	13.80	0.288	0.274	46.88	50.36	7.36	7.43
100 cm^3 NPK humate	13.84	14.00	0.274	0.259	50.51	54.13	7.47	7.62
150 cm^3 EM + 75 cm^3 NPK humate	14.65	14.65	0.224	0.213	65.49	68.94	7.78	8.12
150 cm^3 EM + 100 cm^3 NPK humate	13.95	14.15	0.268	0.241	52.13	58.71	7.56	7.73
200 cm^3 EM + 75 cm^3 NPK humate	14.85	14.85	0.206	0.202	72.09	73.52	7.94	8.38
200 cm^3 EM + 100 cm^3 NPK humate	14.15	14.37	0.288	0.248	49.13	57.96	7.62	7.84
Control	12.90	12.99	0.297	0.288	43.48	45.09	6.66	6.81
NLSD at 5%	0.10	0.07	0.007	0.006	1.76	1.58	2.40	2.61

In conclusion, drenching soil of 'Le Conte' pear orchard with combined application of bio-stimulant (EM) and soil amendment (NPK humate) can be recommend to enhance vegetative growth, nutrient availability, yield and fruit quality of 'Le Conte' pear trees, especially at the rate of 200 cm^3 EM + 75 cm^3 NPK humate/tree/year.

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تأثير المنشطات الحيوية و محفزات التربة على النمو الخضرى، المحصول و جودة ثمار أشجار الكمثرى الليكونت.

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أجريت التجربة الخاصة بالبحث خلال موسمين ناجحين ٢٠١٢/٢٠١١ و ٢٠١٣/٢٠١٢ بمزرعة تجارية بمدينة الخطاطبة محافظة المنوفية، و هى تهدف إلى دراسة إمكانية تعزيز إنتاجية أشجار الكمثرى الليكونت تحت الظروف المحلية فى الأراضى المستصلحة الحديثة باستخدام المنشطات الحيوية و محفزات التربة، حيث أجريت التطبيقات الفردية و المختلطة من المنشط الحيوي (EM) و محفز التربة (NPK humate) بإضافتهما للتربة ١٤ مرة مقسمة بواقع إضافة كل إسبوعين إعتباراً من أول فبراير حتى منتصف أغسطس لدراسة التأثير على النمو الخضرى، توفير المغذيات، المحصول و جودة ثمار أشجار الكمثرى الليكونت. و قد بينت النتائج أن التطبيقات المختلطة من المنشط الحيوي (EM) و محفز التربة (NPK humate) كانت أفضل من التطبيقات الفردية لكل منهما، و بالأخص عند معدل [٢٠٠سم^{٣} (EM) + ٧٥سم^{٣}(NPK humate)] لكل شجرة خلال العام و التى أظهرت أفضل التأثيرات المعنوية لمختلف القياسات المقدرة خلال موسمى الدراسة.