

Effect of Rootstocks, Organic Matter and Different Nitrogen Levels on Growth and Yield of Le-Cont Pear Trees

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Abstract: The Research was conducted at Horticultural Research Institute Orchard, Agriculture Research Center, Giza, Egypt to determine the effect of rootstocks, some organic amendments and three N levels on the vegetative growth, fruit set and yield of Le-Cont pear, *P. communis*, budded on *P. betulifolia*, *P. communis* and *P. calleryana* rootstocks. Tests were conducted during 2008 and 2009 growing seasons. The trees were five years old, planted at a spacing of 3.5×4 m apart in clay soil under drip irrigation system. The trees were subjected to three organic matter treatments; soil application of humic acid (HA) through drip irrigation system (60 cm/tree), HA (30 cm/tree) + compost (5 kg/tree) and compost (10 kg/tree). The N levels were 50%, 75% and 100% of the recommended N level (400 g N/tree) as ammonium nitrate (33.5% N). The main and interaction effects of rootstocks, organic matter and nitrogen (N) levels were tested using split-split-plot experimental design. The vegetative growth characteristics (tree height, trunk diameter, shoot length and diameter, number of leaves/shoot and leaf area) of the trees were significantly affected by the source of organic matter. Since, HA treatment at 60 cm/tree was more effective followed in decreasing order by treatment of HA at 30 cm/tree + Compost at 5 kg/tree then compost at 10 kg/tree. Moreover, 100% N dose gave the highest values of vegetative growth followed by 75% then 50% in both seasons of the study. Fruit set and yield of trees which grown on *P. betulifolia* rootstock were higher than those grown on *P. communis* and *P. calleryana*. Also, HA treatment gave the highest fruit set and yield followed by HA+ compost then compost alone. Yield greatly was affected as N doses application decreased from 100% (15.48 and 20.00 kg/tree) to 75% (14.98 and 19.19 kg/tree) and 50% (14.51 and 18.34 kg/tree) in both seasons, respectively. Results of the physical and chemical proprieties of fruits were in the same trend as aforementioned with organic matter treatments except acidity and TSS as they decreased with HA treatment than with compost treatment.

Key words: Rootstocks • Organic matter • Nitrogen • Yield • Le-Cont pear

INTRODUCTION

Le-Cont is the main pear cultivar that widely grown in Egypt on the main rootstock, *P. communis* that show high susceptibility to pear blights [1]. Rootstocks play an important role for pear production, since, the proper choice of rootstock is an important as the choice of variety and site. This is true because the rootstock is involved in determining two key factors: the variety susceptibility to several serious diseases and the tree's performance in the climate and the orchard site. Stebbins [2] reported that, the principal diseases of pear trees, which related to rootstocks, are fire blight, pear decline and Pseudomonas bacterial blight. Also, rootstocks vary

in their tolerance of heavy soils and cold winter temperatures, their effect on tree vigor and other factors. Moreover, they varied in their advantages such as earlier, heavier production and resistant to several serious diseases. In addition, the same investigator demonstrated that, *P. calleryana* resistant to fire blight, *P. communis*, is lack fire blight resistance and *P. betulifolia* seedling are not resistant to fire blight. However, seedling of *P. communis*, commonly used as the main pear rootstock; also, *P. betulifolia* seedling used in the last few years in a commercial scale and *P. calleryana* seedling are unacceptable rootstock for pear in Egypt because it is susceptible to lime-induced chlorosis although it resistance to fire blight. Because *P. calleryana* is resistant

to fire blight, earlier in blooming, low chilling requirement and often is a good choice as a rootstock for any pear variety [2]. It involved in this study as a trail to solve the chlorosis problem.

Pear produce little crop in some years due to insufficient chilling winter mainly with the trees that grown on *P. communis* rootstock which leads to be infected by fire blight. Consequently, due to the heavily infection of fire blight in the last 20 years, the pear cultivated area in Egypt decreased from 14565 feddan in 1996 to 9931 feddan in 2000 and consequently the yield also decreased from 18 to 1-2 ton/feddan [3]. This may be due to the effect of rootstocks as well as the nutrition manner that consider one of the most effective factors that affecting tree growth, yield and fruit quality. However, Kassem *et al.* [4] found that the high cost of mineral fertilization is a big problem facing fruit trees growers. In addition, the recent research revealed that mineral fertilizers affects tree growth, vigor, productivity, fruit quality and have a role in the health problems and environmental pollution [5]. Also, Yona [6] indicated that organic fertilization plays a key role in the soil micronutrient cycle. Moreover, agriculture lands are impoverished and it is necessary to apply high doses of agrichemicals, which in turn pollute significantly the ecosystem [7]. However, also added that in order to make agriculture sustainable, it is necessary to implement a balanced and responsible use of organic agriculture or at least minimizes the uses of chemical fertilization. Also, sandy soils considered one of the problems that facing the new lands in Egypt are where these soils are very poor in organic matter that have low cation exchange and low water holding capacity which lead to more losses of fertilizers through leaching. Therefore, a great attention has been played to use the organic substances for minimizing the uses of chemical fertilization and in turn improving soil texture.

Humic acid is a constituent of organic matter. It is the most active fraction of humus coupled with fulvic acid. As early as 1930's, work was conducted on humic acid and its ability to stimulate plant growth [8, 9]. For example, Burk *et al.* [10] concluded that the use of humic acid might permit satisfactory or improve growth under substantially neutral or alkaline conditions. In addition, De-Kock [11] focused on iron deficient crops and reported that humic acid influences plant growth and development through its interaction with iron promoting increased plant uptake.

Later in the 20th century, increasing work on humic acid shows that it promotes soil aggregation, water holding capacity of soils, nutrient availability to plant

roots and helps in root development and growth [12-16]. Humic substances have also been documented to improve micronutrient uptake of zinc and iron by plants [16-18]. Additionally, humic acid forms complexes with some metals enhancing the availability of these micronutrients to root plants and improving their uptake [16, 19]. It improves water infiltration in soils that are clayey [9, 14]. Humic acids have been reported to improve the physical structure of soils, increase the cation exchange capacity, soil microbial activity and reduced losses of nutrients through leaching [9, 14]. Additionally, humic acid has been utilized to remediate soils that are polluted reduce the effect of soil salinity on plant growth and development [20].

Several researchers have determined the positive impacts of humic acid on calcareous soils. For example, Katkat *et al.* [9] reported that humic acid increased nitrogen, phosphorus, potassium, iron, manganese and zinc uptake and stimulated an increase in wheat dry weight. Moreover, Bogatyre [21] reported that mineral fertilizers used in agricultural production not only have harmful effects on the environment, but also can alter the composition of fruits and decrease their contents of vitamins, minerals and other useful compounds. They also represent a very great danger because harmful residues may remain in the food due to the limited amounts of safe and clean organic fertilizers. Nowadays in Egypt, many trials are being accomplished to find out the possibility of using some new natural materials to improve soil fertility and productivity of fruit trees. In addition, it was thoughtful to depress to the lower extent the pollution occurring in the Egyptian environment due to the exaggeration in the application of chemicals and mineral fertilizer; so, several studies refer to HA as an organic fertilizer, which in turn very beneficial for increasing the growth and productivity of fruit crops. However, humic materials significantly increased orange and grapefruit trees growth and fruit production [22-24]. Moreover, Fathi *et al.* [25] indicated that soil application of "Actosol®" (humic acid) effectively enhanced shoot length, number of leaves shoot leaf area and yield components of Canino apricot. El-Rmah *et al.* [26] found that all treatments of mineral fertilizer combined with compost and humic acid (Actosol®) gave better effect on trunk and shoot diameter, shoot length and leaf area of young Le-Cont pear trees. El-Seginy [27] also found that soil application of actosol® (HA 20 %) and EM gave significant increase in vegetative growth parameters of pear and apricots trees. In addition, Kandil *et al.* [28] found that 66% of recommended fertilization dose + humic acid (actosol®)

treatment significantly gave the highest increase of trunk diameter, tree size, shoot length, fruit yield per tree, fruit weight, size, diameter and length, as well as total soluble solids (TSS%) and flesh percentage, of Florida Prince peach, while gave significant decrease in fruit firmness and acidity % in both seasons. El-Shall *et al.* [29] indicated that soil and foliar application modes of HA (actosol®) increased the vegetative growth of plum trees. However, soil application was superior to foliar application. Moreover, the combined amendments (soil and foliar application of HA) significantly increased the height and trunk diameter of the trees besides increasing number, length and diameter of shoots during two seasons of study.

The main objectives of this study are, firstly, to determine the role of rootstocks, organic and amendments nitrogen doses on the vegetative growth yield and fruit proprieties of Le-Cont pear. The second objective is to examine the possibility of using the HA organic fertilizer as a substitute to the compost. The third objective is to examine whether the HA can reduce the application rate of inorganic nitrogen fertilizers without posing any risk on the growth and yield of Le-Cont pear.

MATERIALS AND METHODS

Study Site: The Present study was carried out at Horticulture Research Institute Orchard, Agriculture Research Center, Giza, Egypt during the two successive seasons of 2008 and 2009.

Plant Description: Le-Cont pear trees that grown on three different rootstocks, *P.betulifolia*, *P.communis* and *P.callearyana*, were 5-years old planted at spacing of 3.5×4 meters apart on clay soil (Table 1) under drip irrigation system. The recommended horticultural practices to orchard were applied.

Experimental Design: 81 Le-Cont pear trees were chosen to determine the main effects of rootstocks, organic matter and nitrogen levels during split split plot design. Also, all different interactions between factors were examined. The experiment conducted three trees in each treatment and each tree treated as one replicate.

The three rootstocks, *P. petulifolia*, *P. communis* and *P. callearyana* were employed as a main plot. Three types of organic matter application as humic acid alone, humic acid + compost and compost alone were employed as sub plot. While the Nitrogen levels including 50%, 75% and 100%, of the recommended N level dose (400g N/tree) were employed as sub-sub-plot.

Table 1: Some chemical and physical properties of the experimental soil.

Soil properties	Values
pH	8.30
EC(dsm ⁻¹)	1.70
Organic matter %	1.65
CaCO ₃ %	5.39
Particle sized distribution	
Sand	18.20
Silt	23.50
Clay	58.30
Textural grade	Clay
Available nutrients	
Total N %	0.27
Available P (ppm)	5.20
Available K (ppm)	3.8
Fe (ppm)	3.1
Mn (ppm)	0.5
Zn (ppm)	2.66

Table 2: Compost analysis.

Parameters	Value
Weight of m ² (Kg)	650
Moisture (%)	48.3
pH	8.52
EC (dsm ⁻¹)	3.76
Ammonium nitrogen (ppm)	426
Nitrate Nitrogen (ppm)	15
Total N (%)	1.1
Organic matter (%)	38.1
Organic carbon (%)	22.1
Ash (%)	61.9
C/N ratio	1882:1
Total P (%)	0.27
Total K (%)	0.66
Weed seeds	Nil
Nematodes (larve/200g soil)	Nil

The Organic Matter Amendment Applications Were as Follows:

- Humic acid (actosol® form; humic acid is the active ingreding of actosol® product, the natural organic fertilizer who contain 1-5-6 N P K and 20 %; humic acid, commercially knows as potash actosol® and manufactured by ARCTICK Inc, Chentilly, VA, USA) was used as a direct soil application through drip irrigation system at the rate of 60 cm/tree during the following times: at bud burst (late February and early March), after fruit set (almost mid April), mid May and mid June, of each growing season.
- Compost (Table 2), was added at the rate of 10 kg/tree at early January of each season.
- Humic acid (30 cm/tree) + Compost (5 kg/tree) were added in the same time that mentioned before.

The mineral N-fertilization treatments included three rates i.e. 50, 57 and 100% of the recommendation dose of Ministry of Agriculture, Egypt of pear (400gN/tree). Each dose was added as ammonium nitrate (NH_4NO_3 , 33.5%N), where the fertilizer amount was fractioned into differed weekly doses.

Vegetative Growth Measurements: Four main branches were selected and tagged at their cardinal points. The length and diameter of each shoot grown on the selected branches were measured at the end of each season. Number of leaves/shoot and leaf area were calculated at early of October. Tree height (m) and the increment of trunk diameter (cm) for each tree were measured 10 cm above the scion and rootstock union on the first of March and late of December during the two vegetative growing seasons.

Fruit Set %: Six limbs per tree were randomly chosen at the beginning of the growing season, and the total number of flowers on each limb were counted at full bloom. Number of set fruits was counted on the same limbs after one month from full bloom. Fruit set percentage was calculated according to this equation:

Fruit set percentage = (number of developing fruitless / total number of flowers) X 100

Yield was estimated as kg/tree at maturity stage in the first week of August.

Fruit Physical Characteristics: Sample of 10 mature fruits were randomly selected from each replicate at the harvest time for determining the average fruit weight (g), fruit size (cm^3), fruit length (cm), fruit diameter (cm) and fruit firmness using pentameter pressure tester (Lb/inch^2).

Fruit Chemical Characteristics: Total soluble solids (TSS %) was measured in fruit juice by using a Carl Zeiss hand refractometer; and total acidity as malic acid was calculated according to AOAC [30].

Statistical Analysis: Analysis of variance was done for each season separately as split-split plot design, according to procedures reported by Gomez and Gomez [31]. The differences between values of means for treatments were compared by least significant difference (LSD) test at 0.05 levels. Data were analyzed using ANOVA in the MSTAT-C software package [32].

RESULTS AND DISCUSSION

Vegetative Growth:

Tree Height: The main effect of the experimental treatments (Table 3) showed that the tree height was

significantly affected by the rootstocks; where Le-Cont cultivar growth was more vigorous and recorded higher tree height on *P.callareyana* and *P.petulifolia* than on *P.communis*. The tree height was also significantly affected by using the different organic matter sources, since, both of HA and HA + compost treatments were more effective than the compost treatment only. The tree height was not significantly affected by using the different nitrogen levels. However, application of low (50%) and/or medium (75%) levels of nitrogen gave the same effect as that of the higher one (100%).

The effect of interaction between rootstocks and organic treatments showed insignificant differences between them. However, tree height was relatively higher when HA was used alone than the other two treatments. The same trend was also observed with the interaction between the organic matter and nitrogen doses.

The results of the interaction between rootstocks and nitrogen levels indicated that trees height grown on the three rootstocks were significantly affected by nitrogen levels used. However, at any nitrogen dose, trees grown on *P.communis* rootstock were shorter than those grown on the other rootstocks.

Concerning the interaction between rootstocks, organic and N doses, Le-Cont pear grown on *P.calleryana* rootstock with HA only under any N doses treatments (50%, 75% and 100%) gave the best results compared to other interactions under studies in both seasons.

Trunk Diameter Increment: Data in Table 4 showed that trunk growth of Le-Cont pear was significantly affected by the different rootstocks. However, trunk diameter was higher on *P. petulifolia*, followed by *P. calleryana*, than that of on *P. communis* rootstock. Also, Le-Cont pear trees trunk diameter was the highest using full dose of HA alone followed in descending order by (HA + compost) treatment then compost alone. Moreover, 100% N dose gave the highest value of trunk diameter followed by 75% then 50% in both season.

Moreover, there was a remarkable interaction effect between the rootstocks and organic matter sources in this respect. However, the highest value was observed with the trees received HA treatment and grown on *P. petulifolia* followed by *P. callareyana* and *P. communis* in both seasons. Also trunk diameter was higher on *P. petulifolia* than that on the other two rootstocks at any level of N doses. Moreover, an obvious interaction effect was found between the organic matter sources and N doses, since HA or HA + compost treatment was better than compost treatment alone at all N doses.

Table 3: Effect of different Nitrogen levels and some organic matters on tree height (m) of Le-Cont pear grown on three rootstocks.

		Tree height (m)							
		Nitrogen levels (2008)				Nitrogen levels (2009)			
Rootstocks	Organic matter amendments	100%	75%	50%	Average	100%	75%	50%	Average
<i>Pyrus betulifolia</i>	Humic acid (HA)	3.09	2.96	2.92	2.99	3.79	3.64	3.51	3.65
	Compost (Co)	2.73	2.69	2.48	2.63	3.25	3.20	2.98	3.14
	HA+Co	2.88	2.85	2.79	2.84	3.43	3.38	3.30	3.37
	Average	2.90	2.83	2.73	2.82	3.49	3.41	3.26	3.39
<i>Pyrus communis</i>	Humic acid (HA)	2.34	2.23	2.15	2.24	2.85	2.74	2.66	2.75
	Compost (Co)	1.85	1.79	1.74	1.79	2.34	2.28	2.23	2.28
	HA+Co	2.01	1.99	1.89	1.96	2.51	2.43	2.38	2.44
	Average	2.07	2.01	1.93	2.00	2.57	2.48	2.42	2.49
<i>Pyrus calleryana</i>	Humic acid (HA)	3.44	3.38	3.35	3.39	4.07	3.94	3.81	3.94
	Compost (Co)	2.80	2.76	2.43	2.66	3.38	3.20	2.87	3.15
	H+Co	3.28	3.22	3.12	3.21	3.84	3.76	3.66	3.76
	Average	3.17	3.12	2.97	3.09	3.77	3.64	3.45	3.62
General average		2.71	2.65	2.54	2.64	3.27	3.18	3.04	3.16
Average of organic matter	Humic acid (HA)	2.96	2.86	2.81	2.87	3.57	3.44	3.32	3.44
	Compost (Co)	2.46	2.41	2.22	2.36	2.99	2.89	2.69	2.86
	(HA+Co)	2.72	2.69	2.60	2.67	3.26	3.19	3.11	3.19
LSD at 5 %									
Rootstock	(A)		0.28				0.29		
Organic matter	(B)		0.34				0.32		
Nitrogen level	(C)		0.24				0.25		
	AxB		0.30				0.32		
	AxC		0.29				0.31		
	BxC		0.29				0.31		
	AxBxC		0.44				0.51		

Table 4: Effect of different nitrogen levels and some organic matters on trunk diameter (cm) of Le-Cont pear grown on three rootstocks.

		Trunk diameter increment (cm)							
		Nitrogen levels (2008)				Nitrogen levels (2009)			
Rootstocks	Organic matter amendments	100%	75%	50%	Average	100%	75%	50%	Average
<i>Pyrus betulifolia</i>	Humic acid (HA)	2.60	2.30	2.23	2.38	3.04	2.90	2.74	2.89
	Compost (Co)	1.87	1.83	1.43	1.71	2.30	2.29	1.87	2.16
	HA+Co	2.10	2.03	1.97	2.03	2.74	2.50	2.47	2.57
	Average	2.19	2.06	1.88	2.04	2.69	2.57	2.36	2.54
<i>Pyrus communis</i>	Humic acid (HA)	1.53	1.40	1.27	1.40	2.04	1.97	1.84	1.95
	Compost (Co)	1.07	1.03	1.00	1.03	1.50	1.47	1.44	1.47
	HA+Co	1.14	1.13	1.03	1.10	1.67	1.64	1.47	1.60
	Average	1.25	1.19	1.10	1.18	1.74	1.69	1.58	1.67
<i>Pyrus calleryana</i>	Humic acid (HA)	2.47	2.17	2.00	2.21	2.87	2.60	2.44	2.64
	Compost (Co)	1.47	1.40	1.27	1.38	1.87	1.84	1.70	1.80
	H+Co	1.83	1.73	1.60	1.72	2.27	2.17	2.10	2.18
	Average	1.92	1.77	1.62	1.77	2.34	2.20	2.08	2.21
General average		1.79	1.67	1.53	1.66	2.26	2.15	2.01	2.14
Average of organic matter	Humic acid (HA)	2.20	1.96	1.83	2.00	2.65	2.49	2.34	2.49
	Compost (Co)	1.47	1.42	1.23	1.37	1.89	1.87	1.67	1.81
	(HA+Co)	1.69	1.63	1.53	1.62	2.23	2.11	2.01	2.12
LSD at 5 %									
Rootstock	(A)		0.19				0.21		
organic matter	(B)		0.08				0.40		
nitrogen level	(C)		0.09				0.27		
	AxB		0.14				Ns		
	AxC		0.12				Ns		
	BxC		0.12				0.47		
	AxBxC		0.20				Ns		

Table 5: Effect of different nitrogen levels and some organic matters on shoot length (cm) of Le-Cont pear grown on three rootstocks.

		Shoot Length (cm)							
		Nitrogen levels (2008)				Nitrogen levels (2009)			
Rootstocks	Organic matter amendments	100%	75%	50%	Average	100%	75%	50%	Average
<i>Pyrus betulifolia</i>	Humic acid (HA)	40.88	40.33	39.79	40.33	41.50	41.48	41.35	41.44
	Compost (Co)	38.84	38.61	38.40	38.62	40.26	39.80	39.47	39.84
	HA+Co	39.51	39.34	39.32	39.39	41.09	40.89	40.72	40.90
	Average	39.74	39.42	39.17	39.45	40.95	40.72	40.51	40.73
<i>Pyrus communis</i>	Humic acid (HA)	38.90	38.84	38.76	38.83	39.12	39.09	39.07	39.09
	Compost (Co)	38.07	37.81	35.99	37.29	38.40	38.18	37.45	38.01
	HA+Co	38.52	38.35	38.24	38.37	38.65	38.65	38.58	38.63
	Average	38.50	38.33	37.66	38.16	38.72	38.64	38.37	38.58
<i>Pyrus calleryana</i>	Humic acid (HA)	41.95	41.67	41.66	41.76	42.89	42.69	42.62	42.73
	Compost (Co)	41.31	41.16	40.90	41.12	42.25	41.65	41.32	41.74
	H+Co	41.43	41.25	41.10	41.26	42.48	42.41	42.36	42.42
	Average	41.56	41.36	41.22	41.38	42.54	42.25	42.10	42.30
General average		39.93	39.71	39.35	39.66	40.74	40.54	40.32	40.53
Average of organic matter	Humic acid (HA)	40.57	40.28	40.07	40.31	41.17	41.09	41.01	41.09
	Compost (Co)	39.41	39.19	38.43	39.01	40.30	39.88	39.41	39.86
	(HA+Co)	39.78	39.61	39.49	39.63	40.74	40.65	40.55	40.65
LSD at 5%									
Rootstock	(A)			0.17				0.19	
Organic matter	(B)			0.19				0.14	
Nitrogen level	(C)			0.15				0.15	
	AxB			0.33				0.25	
	AxC			0.25				0.26	
	BxC			0.25				0.26	
	AxBxC			0.44				0.65	

Table 6: Effect of different nitrogen levels and some organic matters on shoot diameter (cm) of Le-Cont pear grown on three rootstocks.

		Shoot diameter (cm)							
		Nitrogen levels (2008)				Nitrogen levels (2009)			
Rootstocks	Organic matter amendments	100%	75%	50%	Average	100%	75%	50%	Average
<i>Pyrus betulifolia</i>	Humic acid (HA)	1.58	1.56	1.53	1.56	1.72	1.67	1.66	1.68
	Compost (Co)	1.34	1.28	1.23	1.28	1.52	1.50	1.46	1.49
	HA+Co	1.44	1.43	1.41	1.43	1.55	1.53	1.51	1.53
	Average	1.45	1.42	1.39	1.42	1.60	1.57	1.54	1.57
<i>Pyrus communis</i>	Humic acid (HA)	1.38	1.36	1.36	1.36	1.46	1.45	1.42	1.44
	Compost (Co)	1.23	1.20	1.19	1.21	1.31	1.27	1.23	1.27
	HA+Co	1.27	1.27	1.23	1.26	1.41	1.37	1.31	1.36
	Average	1.29	1.28	1.26	1.28	1.39	1.36	1.32	1.36
<i>Pyrus calleryana</i>	Humic acid (HA)	1.56	1.55	1.51	1.54	1.70	1.65	1.62	1.66
	Compost (Co)	1.44	1.37	1.28	1.36	1.53	1.45	1.42	1.47
	H+Co	1.51	1.48	1.45	1.48	1.62	1.57	1.56	1.58
	Average	1.50	1.47	1.42	1.46	1.62	1.56	1.53	1.57
General average		1.42	1.39	1.36	1.39	1.54	1.49	1.47	1.50
Average of organic matter	Humic acid (HA)	1.51	1.49	1.47	1.49	1.62	1.59	1.57	1.59
	Compost (Co)	1.33	1.28	1.23	1.28	1.46	1.40	1.37	1.41
	(HA+Co)	1.41	1.39	1.37	1.39	1.53	1.49	1.46	1.49
LSD at 5%									
Rootstock	(A)			0.03				0.03	
Organic matter	(B)			0.02				0.02	
Nitrogen level	(C)			0.02				0.02	
	AxB			0.04				0.04	
	AxC			0.04				0.02	
	BxC			0.04				0.02	
	AxBxC			0.06				0.08	

Table 7: Effect of different nitrogen levels and some organic matters on number of levees of Le-Cont pear grown on three rootstocks.

Rootstocks	Organic matter mendments	No. of levees/shoot							
		Nitrogen levels (2008)				Nitrogen levels (2009)			
		100%	75%	50%	Average	100%	75%	50%	Average
<i>Pyrus betulifolia</i>	Humic acid (HA)	39.32	39.00	38.85	39.05	41.40	41.37	41.11	41.30
	Compost (Co)	38.59	38.52	37.75	38.28	40.42	40.18	39.95	40.18
	HA+Co	38.56	38.22	38.16	38.31	40.48	40.45	40.39	40.44
	Average	38.82	38.58	38.25	38.55	40.77	40.67	40.48	40.64
<i>Pyrus communis</i>	Humic acid (HA)	35.62	35.00	34.50	35.04	36.10	36.08	35.39	35.86
	Compost (Co)	32.52	31.20	28.40	30.71	31.42	29.39	28.06	29.62
	HA+Co	33.56	33.37	32.97	33.30	34.58	34.30	34.29	34.39
	Average	33.90	33.19	31.96	33.01	34.04	33.26	32.58	33.29
<i>Pyrus calleryana</i>	Humic acid (HA)	38.00	37.40	37.17	37.52	39.57	39.53	39.50	39.53
	Compost (Co)	36.39	35.61	35.31	35.77	37.98	37.74	37.22	37.65
	H+Co	38.12	37.97	36.41	37.50	38.82	38.51	38.46	38.60
	Average	37.50	36.99	36.30	36.93	38.79	38.59	38.40	38.59
General average		36.74	36.25	35.50	36.17	37.87	37.51	37.15	37.51
Average of organic matter	Humic acid (HA)	37.65	37.13	36.84	37.21	39.03	38.99	38.67	38.90
	Compost (Co)	35.83	35.11	33.82	34.92	36.61	35.77	35.08	35.82
	(HA+Co)	36.74	36.52	35.85	36.37	37.96	37.75	37.71	37.81
LSD at 5%									
Rootstock	(A)			0.35				0.62	
Organic matter	(B)			0.33				0.40	
Nitrogen level	(C)			0.27				0.31	
	AxB			0.58				0.70	
	AxC			0.47				0.53	
	BxC			0.47				0.53	
	AxBxC			0.82				0.92	

Regarding the interaction between the rootstocks, organic matter sources and N doses, the results in Table 4 indicated that trunk diameter of the trees that grown on *P.petulifolia* was not significantly decreased when the N doses was decreased from 100% to 75% or even to 50%. Whereas, HA and HA + compost treatments gave better effect than the compost treatment, although the differences did not reach to the level of significant. The same trend was also observed with the other rootstocks. Since HA treatment gave more values in trunk diameter than that of HA + compost and compost alone, with the three N doses. The results reported in this study indicated that the noticeable tree diameter increment was recorded for trees that received HA as well as combined application of HA + compost and grown on *P. petulifolia* rootstocks.

Shoot Length and Diameter: Tables 5 and 6 clearly indicated that either shoot length or diameter were significantly affected by rootstocks. However, Shoot length and diameter were increased on *P.petulifolia* and *P.callareyana* than that on *P.communis* rootstock. Data also showed that, shoot length and diameter were greatly affected by using different organic substances sources. In this regard, HA treatment exhibit significant increase in these parameters than that of HA + compost or compost alone. Also, HA + compost treatment recorded significant higher values than compost treatment alone. Regarding

the effect of N doses, the tabulated data generally showed that these parameters were not greatly affected by the different N doses, however shoot length and shoot diameter were decreased as the N levels was decreased.

The interaction effect due to rootstocks and the organic matter showed that HA exhibit more effect on shoot length and diameter than that of HA + compost or compost treatments. *P.petulifolia* also gave significant effect than the other two rootstocks at any kind of organic matter treatment. The effect of interaction between the rootstocks and the N doses also showed different effect, however, shoot length and diameter significantly affected by the rootstocks, since *P.petulifolia* gave more values than *P.calleryana* and *P.communis* with the Three N doses, while shoot diameter was not significantly affected by either rootstocks or N levels. The interaction due to the organic matter treatments and N doses also showed the same effect, since, shoot length and diameter were generally decreased as N doses were decreased. Nevertheless, the treatment of full dose of HA resulted in significantly higher shoot length and diameter than those treated with either HA + compost or with full compost dose.

The interaction effect between the rootstocks, organic matter and N levels showed that *P.calleryana* rootstocks with H A under 100% N dose gave the highest values in both seasons as compared with other treatments under the study in both seasons.

Table 8: Effect of different nitrogen levels and some organic matters on leaf area (cm²) of Le-Cont pear grown on three rootstocks.

Rootstocks	Organic matter amendments	Leaf area (Cm ²)							
		Nitrogen levels (2008)				Nitrogen levels (2009)			
		100%	75%	50%	Average	100%	75%	50%	Average
<i>Pyrus betulifolia</i>	Humic acid (HA)	28.91	28.89	28.87	28.89	28.90	28.86	28.82	28.86
	Compost (Co)	27.15	27.12	27.11	27.13	27.20	27.14	27.11	27.15
	HA+Co	28.36	28.25	28.21	28.28	28.19	28.09	27.98	28.08
	Average	28.14	28.09	28.06	28.10	28.10	28.03	27.97	28.03
<i>Pyrus communis</i>	Humic acid (HA)	27.66	27.52	27.51	27.56	27.66	27.56	27.44	27.55
	Compost (Co)	26.66	26.54	26.33	26.51	26.44	25.91	25.91	26.09
	HA+Co	27.35	27.33	27.32	27.33	27.07	26.99	26.97	27.01
	Average	27.22	27.13	27.05	27.14	27.06	26.82	26.77	26.88
<i>Pyrus calleryana</i>	Humic acid (HA)	28.83	28.82	28.82	28.82	28.81	28.50	28.12	28.48
	Compost (Co)	27.16	27.15	27.12	27.14	27.45	27.38	27.22	27.35
	(HA+Co)	28.15	28.14	28.13	28.14	27.88	27.85	27.78	27.83
	Average	28.05	28.04	28.02	28.03	28.05	27.91	27.71	27.89
General average		27.80	27.75	27.71	27.76	27.73	27.58	27.48	27.60
Average of organic matter	Humic acid (HA)	28.47	28.41	28.40	28.43	28.46	28.31	28.13	28.30
	Compost (Co)	26.99	26.94	26.85	26.93	27.03	26.81	26.75	26.86
	(H+Co)	27.95	27.91	27.89	27.92	27.71	27.64	27.57	27.64
LSD at 5%									
Rootstock	(A)			0.14				0.49	
Organic matter	(B)			0.10				0.48	
Nitrogen level	(C)			0.09				0.13	
	AxB			0.18				0.51	
	AxC			0.19				0.53	
	BxC			0.19				0.53	
	AxBxC			0.22				0.72	

Number of Leaves/shoot and Leaf Area: Data in Tables 7 and 8 showed that number of leaves/shoot and leaf area were affected by the rootstocks. Hence, both parameters were significantly higher with *P. betulifolia* followed in decreasing order by *P. calleryana* and *P. communis*. The same trend was also observed with the organic matter treatments, since HA treatment gave significant higher leaf number and area than treatments of HA+ compost and compost alone. Moreover, the double and treble interaction effect between the three factors also exhibits the same trend in this respect. Since, the highest number of leaves/shoot and leaf area were recorded with the HA treatment on *P. betulifolia* and at 100%N dose.

Fruit Set: Data in Table 9 showed that fruit set % was significantly affected by the different rootstocks, organic treatments and N doses. However, fruit set % was more higher with the *P. betulifolia* rootstock and HA treatment followed in decreasing order by the other two rootstocks and HA+ compost and compost alone treatments. Also, fruit set % was increased as N dose decreased, since 50% N dose exhibited more fruit setting than the other two doses in both seasons.

Regarding the effect of the double and treble interactions, data also referred to the same results trend. Since the better fruit setting was shown with *P. betulifolia*

rootstock, HA treatment and low N dose (50%). Also Fruit set % was higher with *P. communis* than *P. calleryana* and HA+ compost gave better effect than compost treatment.

Tree Yield: The yield as affected by the different rootstocks, organic matter sources and nitrogen doses are in Table 10. Data indicated that yield of Le-Cont pear trees was significantly affected by the different rootstocks in both seasons of study. However, the highest yield was observed with the trees that grown on *P. betulifolia* (18.19 and 22.76 kg/tree) followed by that grown on *P. communis* (16.30 and 20.31 kg/tree) and that grown on *P. calleryana* (10.49 and 14.45 kg/tree) in both seasons, respectively. Data also showed that the yield was significantly affected by the different types of organic matter, since the highest yield was obtained from HA treatment (16.47 and 20.51 kg/tree) followed in descending order by treatment of HA + compost (14.87 and 19.79 kg/tree) and compost treatment (13.68 and 17.22 kg/tree) in both seasons respectively. Moreover, 100% N dose gave 15.48 and 20.00(kg/tree), where 75 % N dose gave 14.98 and 19.19(kg/tree) and 50 % N dose gave 14.51 and 18.34(kg/tree) in both seasons, respectively. The difference between 100 % and 75% N doses was not significant and the difference between 75% and 50 % was also not significant in both seasons.

Table 9: Effect of different nitrogen levels and some organic matters on fruit set % of Le-Cont pear grown on three rootstocks.

		Fruit set %							
		Nitrogen levels (2008)				Nitrogen levels (2009)			
Rootstocks	Organic matter amendments	100%	75%	50%	Average	100%	75%	50%	Average
<i>Pyrus betulifolia</i>	Humic acid (HA)	11.99	12.25	12.64	12.29	13.85	14.06	15.65	14.52
	Compost (Co)	10.05	10.12	10.35	10.17	11.12	12.47	13.23	12.27
	HA+Co	11.11	11.33	11.75	11.40	13.13	13.36	14.99	13.83
	Average	11.05	11.23	11.58	11.29	12.70	13.30	14.62	13.54
<i>Pyrus communis</i>	Humic acid (HA)	10.91	11.22	11.64	11.26	14.07	14.11	15.55	14.58
	Compost (Co)	8.55	9.30	9.65	9.17	12.15	12.31	13.18	12.55
	HA+Co	9.41	10.44	10.88	10.24	13.03	13.34	14.00	13.46
	Average	9.62	10.32	10.72	10.22	13.08	13.26	14.24	13.53
<i>Pyrus calleryana</i>	Humic acid (HA)	8.79	9.42	10.00	9.40	11.09	11.77	12.31	11.72
	Compost (Co)	6.33	6.78	7.35	6.82	9.66	9.80	10.52	9.99
	H+Co	7.54	7.74	8.32	7.87	9.68	9.98	10.67	10.11
	Average	7.55	7.98	8.56	8.03	10.14	10.52	11.17	10.61
General average		9.41	9.84	10.29	9.85	11.98	12.36	13.34	12.56
Average of organic matter	Humic acid (HA)	10.56	10.96	11.42	10.98	13.00	13.31	14.50	13.61
	Compost (Co)	8.31	8.73	9.12	8.72	10.98	11.53	12.31	11.60
	(HA+Co)	9.35	9.84	10.32	9.84	11.95	12.23	13.22	12.47
LSD at 5%									
Rootstock	(A)			0.41				2.15	
Organic matter	(B)			0.40				0.93	
Nitrogen level	(C)			0.34				0.50	
	AxB			0.59				1.79	
	AxC			0.58				1.78	
	BxC			0.58				1.78	
	AxBxC			1.01				2.41	

Table 10: Effect of different nitrogen levels and some organic matters on yield (kg/tree) of Le-Cont pear grown on three rootstocks.

		Yield (kg/tree)							
		Nitrogen levels (2008)				Nitrogen levels (2009)			
Rootstocks	Organic matter amendments	100%	75%	50%	Average	100%	75%	50%	Average
<i>Pyrus betulifolia</i>	Humic acid (HA)	20.54	19.80	19.63	19.99	24.53	24.30	23.70	24.18
	Compost (Co)	17.21	16.90	16.11	16.74	22.91	20.55	19.12	20.86
	HA+Co	18.03	17.84	17.64	17.84	23.62	23.10	23.00	23.24
	Average	18.59	18.18	17.79	18.19	23.69	22.65	21.94	22.76
<i>Pyrus communis</i>	Humic acid (HA)	17.73	17.28	17.04	17.35	22.24	22.15	20.35	21.58
	Compost (Co)	15.79	14.98	14.07	14.94	20.11	18.11	17.11	18.44
	HA+Co	16.93	16.38	16.46	16.59	21.13	20.96	20.64	20.91
	Average	16.82	16.21	15.86	16.30	21.16	20.41	19.37	20.31
<i>Pyrus calleryana</i>	Humic acid (HA)	11.99	11.94	11.85	11.93	15.67	16.07	15.56	15.77
	Compost (Co)	10.25	9.26	8.57	9.36	14.22	12.17	10.70	12.36
	HA+Co	10.85	10.47	9.23	10.18	15.55	15.25	14.84	15.21
	Average	11.03	10.56	9.88	10.49	15.15	14.50	13.70	14.45
General average		15.48	14.98	14.51	14.99	20.00	19.19	18.34	19.17
Average of organic matter	Humic acid (HA)	16.75	16.49	16.17	16.47	20.82	20.84	19.87	20.51
	Compost (Co)	14.41	13.71	12.92	13.68	19.08	16.94	15.65	17.22
	(HA+Co)	15.27	14.90	14.44	14.87	20.10	19.77	19.50	19.79
LSD at 5%									
Rootstock	(A)			1.56				0.99	
Organic matter	(B)			0.89				0.93	
Nitrogen level	(C)			0.80				0.88	
	AxB			1.39				1.62	
	AxC			1.38				1.53	
	BxC			1.38				1.53	
	AxBxC			2.39				2.65	

Table 11: Effect of different nitrogen levels and some organic matters on fruit weight (g) of Le-Cont pear grown on three rootstocks.

Rootstocks	Organic matter amendments	Fruit weight (g)							
		Nitrogen levels (2008)				Nitrogen levels (2009)			
		100%	75%	50%	Average	100%	75%	50%	Average
<i>Pyrus betulifolia</i>	Humic acid (HA)	165.21	163.54	163.78	164.18	166.13	166.72	165.94	166.26
	Compost (Co)	152.32	152.12	149.98	151.47	153.23	153.00	152.58	152.94
	HA+Co	158.56	157.32	156.54	157.47	158.88	157.32	158.79	158.33
	Average	158.70	157.66	156.77	157.71	159.41	159.02	159.10	159.18
<i>Pyrus communis</i>	Humic acid (HA)	184.56	183.81	181.54	183.30	186.44	185.45	184.62	185.50
	Compost (Co)	169.47	169.17	169.11	169.25	172.30	171.20	171.13	171.54
	HA+Co	174.80	172.23	172.11	173.05	176.22	176.57	175.43	176.07
	Average	176.28	175.07	174.25	175.20	178.32	177.74	177.06	177.71
<i>Pyrus calleryana</i>	Humic acid (HA)	174.54	172.55	171.79	172.96	176.25	172.49	170.92	173.22
	Compost (Co)	161.87	159.45	159.54	160.29	162.93	163.44	161.97	162.78
	H+Co	165.21	164.65	164.54	164.80	167.75	165.55	167.22	166.84
	Average	167.21	165.55	165.29	166.02	168.98	167.16	166.70	167.61
General average		167.39	166.09	165.44	166.31	176.27	167.97	167.62	170.62
Average of organic matter	Humic acid (HA)	174.77	173.30	172.37	173.48	176.27	174.89	173.82	175.00
	Compost (Co)	161.22	160.24	159.55	160.34	162.82	162.55	161.89	162.42
	(HA+Co)	166.19	164.73	164.39	165.11	167.62	166.48	167.15	167.08
LSD at 5 %									
Rootstock	(A)			1.11				3.27	
Organic matter	(B)			1.33				1.21	
Nitrogen level	(C)			1.66				1.46	
	AxB			Ns				2.10	
	AxC			2.87				Ns	
	BxC			2.87				Ns	
	AxBxC			Ns				Ns	

Yield of Le-Cont pear was greatly affected by the interaction between rootstock, organic and nitrogen dose. However, the yield of the trees grown on *P. betulifolia* and treated with HA under 100, 75 and 50% of N levels were 20.54 and 24.53 kg/tree, 19.80 and 24.3 kg/tree and 19.63 and 23.70 kg/tree in both seasons, respectively. Also, the same treatment with the trees grown on *P. communis* rootstocks gave 17.73 and 22.24 kg/tree, 17.28 and 22.15 kg/tree and 17.04 and 20.35 kg/tree in both seasons, respectively. Whereas, when the trees grown on *P. calleryana* and treated by the above-mentioned treatment gave 11.99 and 15.67 kg/tree, 11.94 and 16.07 kg/tree and 11.85 and 15.56 kg/tree in both seasons, respectively. In general, HA treatment gave the highest yield followed in descending order by treatments of HA + compost and compost alone with three N levels and rootstocks.

Fruit Weight: Data in Table 11 showed that fruit weight was significantly affected by the rootstocks. Since, fruit weight of the trees grown on *P. communis* rootstocks (175.2 and 177.71 g/fruit) was significantly higher than that obtained from trees grown on *P. betulifolia* (157.71 and 159.16 g/fruit) and *P. calleryana* (166.02 and 167.61 g/fruit) in both seasons, respectively. Fruit weight was also affected by the different organic matter

treatments regardless rootstocks and N levels effect, since, HA treatment recorded the heaviest fruit weight (173.48 and 175.8 g/fruit), followed by HA + compost treatment (165.11 and 167.08 g/fruit) and compost alone (160.34 and 162.42 g/fruit) in both seasons, respectively. The effect of N levels on the fruit weight regardless rootstocks and organic matter effect exhibit values of 167.39 and 176.27 g/fruit, 166.55 and 167.97 g/fruit and 165.44 and 167.62 g/fruit for 100, 75 and 50% N levels in both seasons, respectively.

Regarding to the effect of interaction between the organic matter sources and the N doses, it is clearly noticed that HA either used alone or in combination with the compost gave heavier fruit weight more than using compost alone under the three N doses. Hence, a significant increase in the fruit weight was recorded with HA and with HA + compost as compared with compost treatment alone. Also, no great differences were observed between the three N doses with the different organic matter treatments.

Fruit Volume: The results of fruit volume of Le-Cont pear as affected by the three factors under study (Table 12) refer to nearly similar trend as that found with fruit weight. However, fruit volume of trees grown on *P. communis* was more than that on *P. calleryana* and *P. betulifolia*.

Table 12: Effect of different nitrogen levels and some organic matters on fruit size (cm³) of Le-Cont pear grown on three rootstocks.

Rootstocks	Organic matter amendments	Fruit size (cm ³)							
		Nitrogen levels (2008)				Nitrogen levels (2009)			
		100%	75%	50%	Average	100%	75%	50%	Average
<i>Pyrus betulifolia</i>	Humic acid (HA)	166.80	166.74	166.43	166.66	166.93	167.44	166.80	167.06
	Compost (Co)	153.22	153.51	150.02	152.25	156.98	153.87	153.05	154.63
	HA+Co	164.93	161.43	158.54	161.64	166.63	164.55	162.57	164.58
	Average	161.65	160.56	158.33	160.18	163.51	161.96	160.80	162.09
<i>Pyrus communis</i>	Humic acid (HA)	185.33	185.97	184.47	185.25	187.35	186.84	185.26	186.49
	Compost (Co)	172.07	173.20	173.10	172.79	173.78	172.90	172.46	173.05
	HA+Co	175.31	176.73	175.87	175.97	176.38	176.76	176.23	176.46
	Average	177.57	178.63	177.81	178.00	179.17	178.83	177.99	178.66
<i>Pyrus calleryana</i>	Humic acid (HA)	175.21	173.12	172.44	173.59	173.90	173.48	173.14	173.51
	Compost (Co)	162.80	162.81	160.93	162.18	164.20	163.18	162.66	163.34
	H+Co	166.99	166.30	166.44	166.58	168.42	167.33	167.13	167.63
	Average	168.33	167.41	166.60	167.45	168.84	167.99	167.64	168.16
General average		169.18	168.87	167.58	168.54	170.51	169.59	168.81	169.64
Average of organic matter	Humic acid (HA)	175.78	175.28	174.45	175.17	176.06	175.92	175.07	175.68
	Compost (Co)	162.70	163.17	161.35	162.41	164.99	163.32	162.72	163.68
	(HA+Co)	169.08	168.15	166.95	168.06	170.48	169.55	168.64	169.56
LSD at 5%									
Rootstock	(A)			2.21				2.65	
Organic matter	(B)			1.06				1.45	
Nitrogen level	(C)			1.17				1.45	
	AxB			1.84				2.51	
	AxC			Ns				Ns	
	BxC			Ns				Ns	
	AxBxC			Ns				Ns	

Table 13: Effect of different nitrogen levels and some organic matters on fruit length (cm) of Le-Cont pear grown on three rootstocks.

Rootstocks	Organic matter amendments	Fruit length (cm)							
		Nitrogen levels (2008)				Nitrogen levels (2009)			
		100%	75%	50%	Average	100%	75%	50%	Average
<i>Pyrus betulifolia</i>	Humic acid (HA)	6.61	6.58	6.47	6.55	6.64	6.58	6.63	6.62
	Compost (Co)	6.14	6.09	6.07	6.10	6.14	6.08	6.05	6.09
	HA+Co	6.55	6.40	6.19	6.38	6.45	6.36	6.32	6.38
	Average	6.43	6.35	6.24	6.34	6.41	6.34	6.34	6.36
<i>Pyrus communis</i>	Humic acid (HA)	7.17	7.07	7.05	7.09	7.24	7.11	7.04	7.13
	Compost (Co)	6.77	6.57	6.37	6.57	6.76	6.57	6.37	6.57
	HA+Co	7.20	6.99	6.98	7.05	6.98	6.91	6.86	6.92
	Average	7.04	6.87	6.80	6.90	6.99	6.86	6.76	6.87
<i>Pyrus calleryana</i>	Humic acid (HA)	6.98	6.88	6.73	6.86	7.08	6.87	6.73	6.89
	Compost (Co)	6.30	6.22	6.10	6.20	6.26	6.21	6.14	6.20
	H+Co	6.58	6.41	6.16	6.38	6.54	6.52	6.41	6.49
	Average	6.62	6.50	6.33	6.48	6.62	6.53	6.43	6.53
General average		6.70	6.58	6.46	6.58	6.68	6.58	6.51	6.59
Average of organic matter	Humic acid (HA)	6.92	6.84	6.75	6.84	6.99	6.85	6.80	6.88
	Compost (Co)	6.40	6.29	6.18	6.29	6.38	6.29	6.19	6.29
	(HA+Co)	6.77	6.60	6.44	6.60	6.66	6.60	6.53	6.60
LSD at 5%									
Rootstock	(A)			0.28				0.12	
Organic matter	(B)			0.22				0.07	
Nitrogen level	(C)			0.32				0.09	
	AxB			Ns				Ns	
	AxC			Ns				Ns	
	BxC			0.55				Ns	
	AxBxC			Ns				Ns	

Table 14: Effect of different Nitrogen levels and some organic matters on fruit diameter (cm) of Le-Cont pear grown on three rootstocks.

Rootstocks	Organic matter amendments	Fruit diameter (cm)							
		Nitrogen levels (2008)				Nitrogen levels (2009)			
		100%	75%	50%	Average	100%	75%	50%	Average
<i>Pyrus betulifolia</i>	Humic acid (HA)	5.70	5.60	5.50	5.60	5.83	5.73	5.57	5.71
	Compost (Co)	5.31	5.20	5.15	5.22	5.87	5.27	5.36	5.50
	HA+Co	5.41	5.33	5.20	5.31	5.42	5.40	5.21	5.34
	Average	5.47	5.38	5.28	5.38	5.71	5.47	5.38	5.52
<i>Pyrus communis</i>	Humic acid (HA)	6.60	6.40	6.30	6.43	6.70	6.40	6.37	6.49
	Compost (Co)	6.11	5.80	5.70	5.87	5.75	5.37	5.23	5.45
	HA+Co	6.21	6.16	5.90	6.09	6.22	6.17	5.80	6.06
	Average	6.31	6.12	5.97	6.13	6.22	5.98	5.80	6.00
<i>Pyrus calleryana</i>	Humic acid (HA)	6.26	5.81	5.62	5.90	6.28	5.88	5.69	5.95
	Compost (Co)	5.21	5.19	5.13	5.18	5.22	5.16	5.14	5.17
	H+Co	5.43	5.31	5.28	5.34	5.49	5.44	5.28	5.40
	Average	5.63	5.44	5.34	5.47	5.66	5.49	5.37	5.51
General average		5.80	5.64	5.53	5.66	5.86	5.65	5.52	5.68
Average of organic matter	Humic acid (HA)	6.19	5.94	5.81	5.98	6.27	6.00	5.87	6.05
	Compost (Co)	5.54	5.40	5.33	5.42	5.61	5.27	5.24	5.37
	(HA+Co)	5.68	5.60	5.46	5.58	5.71	5.67	5.43	5.60
LSD at 5 %									
Rootstock	(A)			0.38				0.47	
Organic matter	(B)			0.51				0.42	
Nitrogen level	(C)			0.38				0.09	
	AxB			Ns				Ns	
	AxC			Ns				Ns	
	BxC			0.65				0.16	
	AxBxC			Ns				Ns	

Also, HA treatments exhibit better results than compost treatment. Moreover, fruit volume was not greatly affected when the N dose decreased from 100% to 75% or to 50%. Meanwhile, the double and treble interaction effects were in the same trend with the fruit weight.

Fruit Length: Regarding the results tabulated in Table 13, the highest values were observed on the trees which grown on *P. communis* (6.9 and 6.87 cm/fruit) followed by that grown on *P. calleryana* (6.48 and 6.53 cm/fruit) and *P. betulifolia*. (6.34 and 6.36 cm/fruit) in both seasons, respectively. Also, the highest significant values were obtained from full dose of HA (6.64 and 6.88 cm/fruit) followed in descending order by HA+ compost (6.6 and 6.6 cm/fruit) and full dose of compost treatment alone (6.29 and 6.29 cm/fruit). Moreover, the fruit length was not greatly affected when the N dose decreased from 100% (6.7 and 6.68 cm/fruit) to 75% (6.58 and 6.58 cm/fruit) or to 50% (6.46 and 6.51 cm/fruit) in both seasons, respectively. Meanwhile, the different double interactions between the three factors were not significant in both seasons. Also, the treble interaction effect exhibits no significant differences between the treatments in both seasons.

Fruit Diameter: Data of fruit diameter as shown in Table 14 showed the same trend with that obtained from fruit length. Since, the fruits from the trees that grown on *P. communis* rootstocks gave highest values (6.13 and 6.0cm/fruit) than that of *P. calleryana* (4.47 and 5.51 cm) and *P. betulifolia* (5.38 and 5.52 cm). Also, HA treatment (5.98 and 5.05 cm), was better than HA + compost (5.58 and 5.60 cm) and compost only (5.42 and 5.37 cm) in both seasons, respectively. In addition, no great effect was noticed on fruit diameter when the N dose decreased from 100% (5.8 and 5.86 cm) to 75% (5.64 and 5.65 cm) or to 50% (5.53 and 5.52 cm) in both seasons, respectively. Moreover, no significant differences were found due to the interaction between rootstocks and both of organic matter and N levels treatments.

Fruit Firmness: Data in Table 15 showed that firmness of Le-Cont pear fruits was significantly differed as rootstocks differed. However, firmness of the fruits from the trees grown on *P. calleryana* (19.74 and 19.85 cm/Lb²) was significantly higher than that grown on *P. betulifolia* (18.9 and 18.91 cm/Lb²) and the later was more than that of *P. communis*. (17.83 and 17.86 cm/Lb²). Also, firmness was greatly affected by the different organic matter treatments.

Table 15: Effect of different Nitrogen levels and some organic matters on fruit firmness (Lb²) of Le-Cont pear grown on three rootstocks.

		Fruit firmness (Lb ²)							
		Nitrogen levels (2008)				Nitrogen levels (2009)			
Rootstocks	Organic matter amendments	100%	75%	50%	Average	100%	75%	50%	Average
<i>Pyrus betulifolia</i>	Humic acid (HA)	18.16	18.36	18.57	18.36	18.17	18.34	18.53	18.35
	Compost (Co)	19.22	19.42	19.55	19.40	19.29	19.41	19.55	19.42
	HA+Co	18.66	18.80	19.34	18.93	18.62	18.91	19.35	18.96
	Average	18.68	18.86	19.15	18.90	18.69	18.89	19.14	18.91
<i>Pyrus communis</i>	Humic acid (HA)	17.26	17.33	17.42	17.34	17.25	17.31	17.49	17.35
	Compost (Co)	18.21	18.42	18.52	18.38	18.10	18.42	18.51	18.34
	HA+Co	17.65	17.81	17.84	17.77	17.69	17.82	18.17	17.89
	Average	17.71	17.85	17.92	17.83	17.68	17.85	18.06	17.86
<i>Pyrus calleryana</i>	Humic acid (HA)	19.21	19.25	19.44	19.30	19.25	19.43	19.46	19.38
	Compost (Co)	20.18	20.32	20.52	20.34	20.15	20.22	20.53	20.30
	H+Co	19.11	19.91	20.13	19.72	19.61	19.90	20.13	19.88
	Average	19.50	19.83	20.03	19.79	19.67	19.85	20.04	19.85
General average		18.63	18.85	19.04	18.84	18.68	18.86	19.08	18.87
Average of organic matter	Humic acid (HA)	18.21	18.31	18.48	18.33	18.22	18.36	18.49	18.36
	Compost (Co)	19.20	19.39	19.53	19.37	19.18	19.35	19.53	19.35
	(HA+Co)	18.47	18.84	19.10	18.81	18.64	18.88	19.22	18.91
LSD at 5%									
Rootstock	(A)			0.06				0.23	
Organic matter	(B)			0.07				0.15	
Nitrogen level	(C)			0.06				0.13	
	AxB			0.12				0.31	
	AxC			0.11				0.32	
	BxC			0.11				0.32	
	AxBxC			0.19				0.63	

Table 16: Effect of different Nitrogen levels and some organic matters on total soluble solids (TSS %) of Le-Cont pear grown on three rootstocks.

		Total soluble solids (TSS %)							
		Nitrogen levels (2008)				Nitrogen levels (2009)			
Rootstocks	Organic matter amendments	100%	75%	50%	Average	100%	75%	50%	Average
<i>Pyrus betulifolia</i>	Humic acid (HA)	13.21	13.25	13.29	13.25	13.22	13.25	13.28	13.25
	Compost (Co)	12.49	12.55	12.71	12.58	12.46	12.48	12.61	12.52
	HA+Co	12.95	12.99	13.11	13.02	12.66	12.68	12.91	12.75
	Average	12.88	12.93	13.04	12.95	12.78	12.80	12.93	12.84
<i>Pyrus communis</i>	Humic acid (HA)	12.33	12.40	12.43	12.39	12.31	12.42	12.44	12.39
	Compost (Co)	11.34	11.60	11.81	11.58	11.33	11.45	11.61	11.46
	HA+Co	11.75	11.81	12.20	11.92	11.77	11.83	12.12	11.91
	Average	11.81	11.94	12.15	11.96	11.80	11.90	12.06	11.92
<i>Pyrus calleryana</i>	Humic acid (HA)	11.26	11.37	11.55	11.39	11.31	11.32	11.55	11.39
	Compost (Co)	10.47	10.52	10.68	10.55	10.42	10.51	10.66	10.53
	H+Co	10.67	10.75	11.25	10.89	10.53	10.71	11.22	10.82
	Average	10.80	10.88	11.16	10.94	10.75	10.85	11.14	10.91
General average		11.83	11.92	12.11	11.95	11.78	11.85	12.04	11.89
Average of organic matter	Humic acid (HA)	12.27	12.34	12.42	12.34	12.28	12.33	12.42	12.34
	Compost (Co)	11.43	11.56	11.73	11.57	11.40	11.48	11.63	11.50
	(HA+Co)	11.79	11.85	12.19	11.94	11.65	11.74	12.08	11.82
LSD at 5%									
Rootstock	(A)			0.11				0.23	
Organic matter	(B)			0.10				0.16	
Nitrogen level	(C)			0.09				0.08	
	AxB			0.21				0.33	
	AxC			0.14				0.13	
	BxC			0.14				0.13	
	AxBxC			0.41				0.52	

Table 17: Effect of different Nitrogen levels and some organic matters on acidity (%) of Le-Cont pear grown on three rootstocks.

		Acidity (%)							
		Nitrogen levels (2008)				Nitrogen levels (2009)			
Rootstocks	Organic matter amendments	100%	75%	50%	Average	100%	75%	50%	Average
<i>Pyrus betulifolia</i>	Humic acid (HA)	0.2633	0.2603	0.2593	0.2610	0.2577	0.2567	0.2517	0.2554
	Compost (Co)	0.2810	0.2763	0.2733	0.2769	0.2840	0.2753	0.2720	0.2771
	HA+Co	0.2693	0.2663	0.2653	0.2670	0.2683	0.2637	0.2660	0.2660
	Average	0.2712	0.2676	0.2660	0.2683	0.2700	0.2652	0.2632	0.2662
<i>Pyrus communis</i>	Humic acid (HA)	0.2563	0.2533	0.2503	0.2533	0.2510	0.2500	0.2470	0.2493
	Compost (Co)	0.2693	0.2673	0.2653	0.2673	0.2803	0.2767	0.2720	0.2763
	HA+Co	0.2643	0.2613	0.2583	0.2613	0.2707	0.2673	0.2620	0.2667
	Average	0.2633	0.2606	0.2580	0.2606	0.2673	0.2647	0.2603	0.2641
<i>Pyrus calleryana</i>	Humic acid (HA)	0.2933	0.2913	0.2893	0.2913	0.2843	0.2830	0.2810	0.2828
	Compost (Co)	0.3063	0.3043	0.3010	0.3039	0.3490	0.3383	0.3180	0.3351
	H+Co	0.2993	0.2983	0.2953	0.2976	0.2993	0.2987	0.2967	0.2982
	Average	0.2996	0.2980	0.2952	0.2976	0.3109	0.3067	0.2986	0.3054
General average		0.2780	0.2754	0.2730	0.2755	0.2827	0.2789	0.2740	0.2785
Average of organic matter	Humic acid (HA)	0.2710	0.2683	0.2663	0.2685	0.2643	0.2632	0.2599	0.2625
	Compost (Co)	0.2855	0.2826	0.2799	0.2827	0.3044	0.2968	0.2873	0.2962
	(HA+Co)	0.2776	0.2753	0.2730	0.2753	0.2794	0.2766	0.2749	0.2770
LSD at 5%									
Rootstock	(A)			0.0014				0.0107	
Organic matter	(B)			0.0007				0.0109	
Nitrogen level	(C)			0.0004				0.0079	
	AxB			0.0013				0.0189	
	AxC			0.0007				0.0132	
	BxC			0.0007				0.0132	
	AxBxC			0.0011				0.0522	

Since compost gave significant higher values (19.37 and 19.35 cm/Lb²) followed in descending order by treatments of HA + compost (18.81 and 18.91 cm/Lb²) and HA alone (18.33 and 18.36 cm/Lb²). Moreover, Fruit firmness significantly increased as N dose decreased, since 50% N dose gave more higher values (19.04 and 19.08 cm/Lb²) than 75% N dose (18.85 and 18.86 cm/Lb²) and 100% N dose (18.63 and 18.68 cm/Lb²).

The results obtained from the interaction between the three factors appeared that higher values of fruit firmness were observed with the tree grown on *P. calleryana* and treated with compost and 50% N dose (20.52 and 20.53 cm/Lb²), followed by those treated with HA + compost and HA alone and grown on *P. betulifolia* and *P. communis*, although the differences were not significant in the second season.

Total Soluble Solids (TSS): Data in Table 16 showed that TSS of Le-Cont pear fruits was greatly affected by the different rootstocks, since *P. betulifolia* exhibit significant effect in this respect (12.95 and 12.84 %) followed in decreasing order by *P. communis* (11.96 and 11.92 %) and *P. calleryana* (10.94 and 10.91%) in both seasons. The effect of organic matter treatments also gave significant differences, since, HA treatment gave higher values (12.34 and 12.34%) followed in decreasing order by

treatments of HA + compost (11.94 and 11.82 %) and compost alone (11.57 and 11.50 %). Also TSS significantly affected by the different N doses. However, TSS increased as N dose decreased, since, 50% N dose, gave TSS higher than that of 75% and 100% N doses. No significant differences were observed from the interaction between rootstocks and organic matter in both seasons. Also, no significant effect was obtained related to the interaction between rootstocks and N dose; as the higher TSS values were obtained from fruits of the trees that grown on *P. betulifolia* and received 50% N dose followed in decreasing order by that grown on *P. communis* and *P. calleryana* and received the other two N doses. The TSS values of 50% N dose were higher than that of 75% and 100% N dose in both seasons. The same trend was also observed with the treble interaction between three factors under study but without significant differences between them in both seasons.

Acidity: Data in Table 17 indicated that Le-Cont pear fruit acidity was significantly affected by the different rootstocks. However, Fruit acidity was higher on the *P. calleryana* than the other two rootstocks in both seasons. Whereas, the differences between *P. betulifolia* and *P. communis* were not significant in the second seasons. Fruit acidity was also affected by the organic

matter treatment since, the compost treatment gave higher values than the other treatments in both seasons and the acidity values were higher on *P. communis* than *P. betulefolea*, although the differences between the two rootstocks did not reach the level of significant in the second seasons. Moreover, fruit acidity did not greatly affected with the three N doses, although, the fruit acidity increased as N dose increased and 100% N dose gave significant increases than the other two doses in both seasons, where as the differences between the other N doses were not significant in the second one.

Regarding the interaction between organic matter and N dose treatments, HA alone and HA + compost treatment gave less acidity values than compost alone under the three N doses and the least values were observed with 50% N dose.

DISCUSSION

Rootstocks, mineral and organic fertilization generally affect tree growth, vigor, productivity and fruit quality, where several studies showed the important role of nutrition and the beneficial effects of organic substances on different fruit species, which can affect trunk growth of fruit trees and considered to be an indicator of tree growth [33].

Therefore, tree height, trunk diameter, shoots length and diameter, leaf area and number of leaves /shoot, were estimated in this study to evaluate the vegetative growth of Le-Cont pear trees grown on *P. communis*, *P. petulifolia* and *P. calleryana* rootstocks. The trees were served with three organic matter treatment i.e. HA or compost alone at full dose and HA+ compost at half dose. The trees also received three N doses i.e. 50%, 75% and 100% of the recommended dose 400g/tree). The results of the vegetative growth of this study generally indicated that Le-Cont cultivar growth was more vigorous on *P. petulifolia* and *P. callareyana* than that on *P. communis*. These results are similar to those of EL-Azzoani and EL-Mahmoudy [34], as they noticed that vigorous Le-Cont pear trees were observed on *P. callareyana* rootstock, while those on *P. communis* rootstock were of intermediate size. EL-Azzoani *et al.* [35]. Mentioned that *P. calleryana* had proved to be superior to *P. communis* and appeared to be the most suitable rootstock for Le-Cont variety during its early years of growth. The result reported herein on organic matter (OM) refer to when HA used alone at full dose generally increased the vegetative growth of the trees than when used + compost at half dose and also when compared with the compost alone.

The promising effect of HA on the vegetative growth of the trees may be attributed to the finding

of several studies which disclosed that humic substances may improve physical and chemical soil properties, favor a higher concentration of ions in soil solution and act as sours and sink for nutrients such as P, N and K [36]. Also, it has been suggested that humic fractions exhibit high hormonal activity and, in particular, auxin-like activity [15]. Also, Lee and Bartlett [37] indicated that HA is a vital constituent and an intimate part of soil organic structure which has been required and used by many soil scientists, agronomists and farmers as an essential constituent of organic matter highly effective in improving soil condition and plant growth. Petrovic and vitorovic [38] reported that addition of HA to soil increases the rate of absorption of mineral ions on root surfaces and their penetration into the cells of the plant tissue. They also added that plants show more active metabolism and increased respiratory activity.

Moreover, in this respect, Bottomly [39-42] in the early 20th century, published a series of papers in which he showed that humic substances enhanced the growth of various plant species in mineral nutrient solution. Bottomly believed humic substances acted as plant growth hormones and called them "auximones". Other investigators such as Olsen [43] and Burk *et al.* [10] attributed the beneficial effects of humic substances on plant growth to the increased solubilization of some mineral ions such as Fe. All of these activities are attributed and explained due to the reaction of organic compounds like amino acids with the quinines groups of HA which lead to degradation of amino acid for plants assimilation [48].

This positive effects of HA for promoting the vegetative growth of Le-Cont pear has been documented by El-Seginy [27], who found that soil treatment of (actosol®) a humic acid fertilizer and EM gave a significant increase in vegetative growth parameters of pear and apricot. Fathi *et al* [25]. indicated that soil application of (actosol®) effectively enhanced shoot/length, number of leaves/shoot, leaf area and yield components of Canino apricot. Kandil *et al.* [28] also found that 66% of recommended fertilization doses+HA (actosol®) treatment gave the highest increase of trunk area, tree size, shoot length, diameter and yield of Florida prince peach. El-Ramah *et al.* [26] indicated that all treatment of mineral fertilizer with compost and HA (actosol®) gave better effect on trunk and shoot diameter, shoot length and leaf area of young Le-Cont pear trees. El-Shall *et al.* [29] also found that the application of HA significantly increased the height and trunk diameter of plum trees as well as the number, length and diameter of shoots.

The results of this study also refer to the positive effect of HA, in particular, on plant nutrient use efficiency since the chemical fertilizers are becoming more expensive due to elimination of subsidy, declining efficiency of fertilizers and issues related, to mismanagement at farm levels (Freney and Simpson, [44]. The results also supported by the finding of Yagodin [45], De-Ell and Prang [46], Mba [47] and El-Haggar *et al.* [48]. They reported that HA, as an organic fertilizer, is very beneficial in increasing the productivity of fruit crops. That is due to the conversion of unavailable minerals into soluble forms that plants can use. Also, it is to improve plant nutrition by stimulating the absorption of mineral elements through the roots, stimulating root growth, especially in the vertical direction. Thus, enabling better uptake of nutrients, retaining water-soluble inorganic fertilizers in the root zones, reducing their leaching and enhancing the uptake of nitrogen by plants. The role of these organic fertilizers through improving growth, chlorophyll content enhanced photosynthesis and increased tissue concentrations of N, K was supported by many workers [23, 49-51]. The results of yield, fruit physical and chemical characteristics in this study are supported by several investigators. However, Kandil *et al.* [28] found that 66% of recommended fertilization dose + HA gave the highest increases of yield and fruit physical and chemical characteristics of Florida Prince peach and significantly decreased fruit firmness, TSS and acidity content. The effect of HA and its usefulness in increasing the yield and fruit quality are also in line with Hussien *et al.* [51] on pear, Zhu and Zhu [52], Ali *et al.* [53] on grapevine and Ismail *et al.* [54]. The results of the previous investigators, regarding the role of organic fertilizers for increasing nutrient use efficiency, as well as improving the growth, yield and quality of several fruit trees; also support and explain why the low N dose 75% or 50% gave the same effect on the studied vegetative growth parameters, yield and fruit characteristics of Le-Cont pear as the recommended one (100%) with the treatment of HA in this study.

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