THE INFLUENCE OF TWO TRAINING SYSTEMS AND THREE TREE SPACING ON THE PERFORMANCE OF LE CONTE PEAR TREES.

By

*Abd-EL-Messeih,W.M., ** El-Seginy Amal M. and Naiema Malaka S.M.

*Hort.Res.Station, Nubaria.**Hort.Res.Station, Sabahia Hort.Res.Ins, Agric.Res.Center, Egypt.

ABSTRACT

This study was carried out during (2001-2002) and (2002-2003) growing seasons on the 15 years old of "le Conte" pear trees grown at Nubaria Horticultural Research Station, aiming to evaluate the two training systems (Vase shape and Espalier form) and three tree spacing (5x5m,5x4m and 4x4m).

In general, the obtained data clearly showed the superiority of Vase shape system with 5x5m tree spacing which gave the widest shoot-cross sectional-area, the longest length of new shoot, the largest leaf area and the highest tree size during the two experimental seasons .On the other hand, Espalier system with 4x4m tree spacing gave the lowest value for the same mentioned parameters.

Espalier shape at three tree spacing produced high total leaf chlorophyll content, flower number per cluster, fruit set % and yield efficiency as comparing with Vase shape system at the same planting distances during the two experimental seasons.

Vase shape trees with 5x5m followed 5x4m tree spacing increased N, P, K, Ca, Mg, Mn, Fe and Zn during study seasons. Meanwhile, the Espalier shape decreased the value for above mineral content.

Yield as weight per tree and fruit quality (average fruit weight, fruit dimensions, acidity % and firmness of fruit) were significantly increased by Vase shape system with three tree spacing during both seasons as compared with Espalier form. Meanwhile, Espalier training system with three tree spacing increased the T.S.S % and total sugars % in the two studied seasons.

INTRODUCTION

Le Conte pear is one of the important deciduous fruit crops grown in Egypt. It suffers from several factors, which have a negative effect on its production. Therefore, the grown area is reduced. There is a very important

question about the best training and the best distance between trees and rows that enable pear trees to be exposed to adequate light for maximum yield and vegetative growth .The most important reason for training is to improve light exposure of bearing surface to maintain fruitfulness and improve fruit quality (Barden, 1977).

The zone of trees that revive <30% of full sun light is less fruitful and produce smaller fruits of inferior quality .Also a decreased in perfect cone tree size from 5 to 2.5 m^3 reduced the heavily shaded interior from 24.4% of the total tree to 1.6%, if the effective light will penetrate no more than 1m into the canopy, (Forshey *et al.*, 1992).

The crop is the product of the interaction of two factors; the total production of dry matter per unit of land and the partitioning of the dry matter between fruit and wood (Quinlan 1975).In a large tree with a globular continuous canopy there is a core in the center of the tree which has insufficient light for the production of fruit quality (Heinicke,1975).Light is an important aspect of canopy studies because of its role in photosynthesis ,its function in developing morphology of leaves and shoots, its role in flower initiation and fruit set and its importance of fruit development and quality (Rom,1989.)

Some investigations were carried out on apple trees, using Espalier training system owing to the branches of apple trees are flexible and easily contoured and stretched to the desirable pattern intended (El-Banna *et al.*, 1993 and Khalil *et al.*, 2000). Nevertheless, the pear tree branches are relatively different because they are rigid which hinder contouring and shaping.

Accordingly, this trial was carried out to study the influences of the two training system (Vase shape and Espalier form) and three tree spacing (5x5m, 5x4m and 4x4m) design on the vegetative growth, some leaf mineral contents, total leaf chlorophyll, flower number per cluster, fruit set %, yield efficiency, yield and fruit quality of Le Conte pear trees grafted on *Pyrus communis*, L. rootstock.

MATERIALS AND METHODS

The present investigation was carried out at El-Nubaria Horticultural Research Station, El-Beheira Governorate ,during the two successive seasons, (2001-2002) and (2002-2003), on the 15 year old of Le Conte pear trees (*Pyrus communis* L.x *Pyrus pyrifolia* N.) on *Pyrus communis* rootstock ,planted in calcareous soil. The analysis of the experimental soil's orchard

was determined according to the method of Chapman and Pratt (1961) before starting the experiment and the data are presented in Table (1).

Table (1): Soil characters.

Texture	pH	Total CaCO3%	EC. (sd/m)	O.M. (%)
Sandy loam	7.95	30.52	1.36	0.53

All trees were furrow irrigated with Nile water, and fertilizers were applied on orchard managements.

Forty eight trees were selected nearly equal and treated with normal agriculture practices and received the following treatments:

1-Vase shape canopy with 5x5m.tree spacing.
2-Vase shape canopy with 5x4m.tree spacing.
3- Vase shape canopy with 4x4m tree spacing.
4- Espalier form with 5x5m tree spacing.
5- Espalier form with 5x4m tree spacing.
6- Espalier form with 4x4m tree spacing.

The experiment treatments were arranged in a randomized complete blocks design and each treatment was replicated four times with two trees in each replicate, i.e. 2 training systems x3 tree spacing x4 replicates x2 experimental units = 48 trees, the following parameters were determined in the two growing seasons.

1-Vegetative growth: (Including: shoot cross-sectional area- average length of new shoots- leaf area- tree size.)

Average shoot cross-sectional area (cm^2) was calculated according to the formula: circumference $=2\pi r$ and cross sectional area$=\pi r^2$, where $\pi = 3.14$ and r = 1/2 diameter (Westwood, 1988).Average length of new shoots (cm). Determine the leaf area using leaf area meter Model (l-203, CID, Inc, USA) at the first of September. The height and diameter of canopies were measured per meter on mid October to determine tree size.

2- Leaf Analysis: (Including: total leaf chlorophyll- some leaf mineral content)

- Total leaf chlorophyll: It was determined using Minolta Chlorophyll Keter Spad 202 (Minolta Camera LTD Japan) at the field on mid June.
- Leaf mineral content: In late July a leaf sample of 40 leaves was collected from each experimental tree from the middle part of the outer shoots and washed with tap water, distilled water and oven dried at 70 °C to a

constant weight. The dried leaves were ground and digested with sulphuric acid and hydrogen peroxide according to Evenhuis and DeWaard (1980). Suitable aliquots were taken for the determination of mineral elements. N and P were determined calomertically according to Evenhuis (1976) and Murphy and Riley (1962), respectively, K was determined by flame photometer, while Ca, Mg, Fe, Mn and Zn by Perkin-Elemer Atomic Absorption Spectrophotometer. (AAS) Macro and micro elements were expressed as percent (%) and part per million (ppm), respectively.

3-Flowering and production: (Including: Flower number per cluster-fruit set percentage, yield efficiency, yield and fruit quality)

-Flower number per cluster: The total number of flowers at full bloom was determined in 10 shoots at random per tree.

-Fruit set percentage: The total number of flowers on each limb was counted at full bloom. The number of set fruits was counted on the same limbs after one month from full bloom. Fruit set percentage was calculated as follows;

$$\text{Fruit set percentage} = \frac{\text{Number of developing fruitlets}}{\text{Total number of flowers}} \times 100$$

-Yield efficiency: It was calculated according to Westwood (1988) using the following equation:

$$\text{Yield efficiency} = \frac{\text{Yield (kg)}}{\text{Trunk cross-sectional area (cm}^2\text{)}}$$

-Yield: The total yield of each tree was determined as weight in Kg/ tree in late August.

-The fruit quality: from the yield of each experimental tree, 20 mature fruits were taken at random for determination of fruit quality. In each sample the average fruit weight was recorded as (gm), fruit dimensions (length and diameter in cm), firmness was determined by Magness and Taylor (1925) pressure tester using a 5/16 plunger. In juice, total soluble solids (TSS %) was determined using a hand refractometer and acidity % was measured according to AOAC (1980). Total sugars content was determined according to Malik and Singh (1980).

The obtained data through out the studied growing season were statistically analyzed according to Snedecor and Cochran (1990) and LSD test at 0.05 level was used for comparison between treatments.

RESULTS AND DISCUSSION

1 .Vegetative growth:

Vegetative growth of Le Conte pear trees in both seasons for different treatments is shown in Table (2).

The tabulated data indicate that Vase shape with 5x5m followed by 5x4m followed by 4x4m tree spacing induced significantly the widest shoot cross-sectional area, the longest average of new shoots, and the largest leaf area and tree size as compared with Espalier form at the same three tree spacing. While the lowest value for the above mentioned parameters was obtained by Espalier training with 4x4m during the two experimental seasons. In general these results are in line with Mitchell *et al.,* (1986), Terence *et al.,* (1991), EL- Banna *et al.,* (1993) and Khalil *et al.,* (2000) they worked on pear and apple trees, respectively and concluded that Vase shape increased the values of these parameters as the planting distance increased than Espalier form.

2. Leaf analysis:

-Total leaf chlorophyll: It is apparent from Table (2) that Espalier training with the three investigated tree spacing (5x5m,5x4m and 4x4m)significantly increased the total chlorophyll content in leaves during the two seasons as compared anther training under this study. This result may be due to that Espalier training system is more relatively exposed to sunlight than Vase system.

-As for leaf mineral content, it is clear from the data in Table (3) that the results indicate high amount of almost elements (N, P, K, Ca, Mg, Fe, Mn and Zn) for Vase shape trees with 5x5m followed 5x4m tree spacing as compared with Espalier system at the same spaces in both seasons. These results could be due to that the high tree size induced ,in turn, large root system with good distribution in the soil causing significantly higher level of leaf elements and vice versa. On the other hand, in spite of this clear significant difference between treatments, all leaf elements were in the normal range.

3. Flowering and production:

It is apparent from Table (4) among all orchard production the Espalier training system at three tree distance gave the highest significant flower

Tabel (2): Effect of different training systems and tree spacing on shoot-cross- sectional-area, shoot length,leaf area, tree size and total leaf chlorophyll of 'Le Conte". pear trees during 2002 and 2003 seasons

Treatments		Shoot-cross-sectional-area (cm2)		Shoot length (cm)		Leaf area(cm2)		Tree size (m3)		Total leaf chlorophyll	
Tree shape	tree spacing (m)	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
Vase shape	5x5	0.660	0.680	86.750	88.500	28.870	30.450	11.507	12.210	38.830	39.500
Vase shape	5x4	0.540	0.540	79.000	80.000	28.170	29.420	8.899	9.759	37.650	38.000
Vase shape	4x4	0.410	0.420	76.500	75.750	26.650	26.930	7.795	9.083	36.750	37.400
Espalier form	5x5	0.430	0.440	64.750	65.000	26.920	27.050	4.514	4.847	40.420	40.630
Espalier form	5x4	0.420	0.430	63.250	62.250	25.920	26.600	4.200	4.389	40.150	40.150
Espalier form	4x4	0.370	0.370	60.250	61.250	25.370	25.500	3.922	4.042	39.850	39.950
L.S.D. at 0.05		0.027	0.048	3.173	2.506	1.133	1.381	0.779	0.629	1.092	0.763

Tabel (3): Effect of different training systems and tree spacing on leaf mineral composition (on dry weight basis) of " Le Conte" pear trees during 2002 and 2003 seasons.

Treatments		N%		P%		K%		Ca%		Mg%		Fe (ppm)		Mn (ppm)		Zn (ppm)	
Tree shape	tree spacing (m)	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
Vase shape	5x5	2.30	2.40	0.20	0.22	1.27	1.29	1.35	1.36	0.33	0.35	111.00	116.00	58.00	59.00	44.00	45.00
Vase shape	5x4	2.20	2.20	0.19	0.21	1.21	1.24	1.30	1.33	0.29	0.32	110.00	112.00	57.00	57.00	41.00	44.00
Vase shape	4x4	2.00	2.10	0.18	0.19	1.18	1.20	1.22	1.28	0.22	0.29	108.00	109.00	55.00	55.00	39.00	40.00
Espalier form	5x5	2.10	2.20	0.19	0.20	1.15	1.16	1.24	1.26	0.22	0.25	106.00	108.00	52.00	55.00	38.00	40.00
Espalier form	5x4	2.10	2.20	0.19	0.20	1.14	1.16	1.23	1.25	0.22	0.25	105.00	108.00	51.00	54.00	38.00	40.00
Espalier form	4x4	1.90	2.00	0.17	0.18	1.12	1.15	1.21	1.25	0.21	0.23	105.00	106.00	51.00	53.00	36.00	38.00
L.S.D. at 0.05		0.23	0.21	0.02	0.03	0.05	0.02	0.05	0.02	0.02	0.03	3.98	2.52	3.01	2.02	2.61	2.39

number per cluster, fruit set% and yield efficiency as compared with Vase shape during both seasons. The result for fruit set agreed with, Khalil *et al.*, (2000) and disagree El-Banna, (1993) who worked on Anna apple trees. While the results of yield effciency are nearly in line with Mitchell *et al.*, (1986), Westwood (1988), Rom (1989) and Forshey *et al.*, (1992) on pear and apple tress, respectively.

Yield and fruit quality:

It is clear from Tables (4) and (5) that the Vase shape tree with 5x5m, followed by 5x4m and 4x4m tree spacing induced increased significantly yield per tree and physical properties (the fruit weight, fruit dimension, fruit firmness) and fruit acidity compared with Espalier form in both seasons. On the other hand, the Espalier tree with the three trees spacing gave the highest significant values TSS % and total sugars as compared training during the two experimental seasons. These results agree to some extent with Abbott (1960) Mitchell *et al.*, (1989), Barritt *et al.*, (1987) El-Banna *et al.*, (1993) and Khalil *et al.*, (2000) on Barttlet pear and Anna apple trees, respectively.

CONCLUSION

Finally, from the pervious discussion we can conclude the following:

The obtained data, generally, showed the superiority of Vase shape system with 5x5m tree spacing which gave the best vegetative growth (shoot cross-sectional-area, length of new shoots ,leaf area and tree size) during the two experimental seasons. As for leaf mineral content, it was increased N, P, K, Ca, Mg, Mn, Fe and Zn during both study seasons. According to yield as weight and fruit quality (average fruit weight, dimensions and firmness of fruits) significantly increased during both seasons.

As we see, Espalier form at three tree spacing (5x5m,5x4m and 4x4m) were only superior in total leaf chlorophyll ,flower number per cluster ,fruit set %, yield efficiency and some chemical properties such (TSS %, total sugar).

For these concepts, Vase shape training system at 5x5m tree spacing is more profitable than Espalier system under the conditions of this study.

Tabel (4):Effect of different training systems and tree spacing on tree flowers number per cluster, fruit set, yield efficiency and yield per tree of " Le Conte" pear trees during 2002 and 2003 seasons

Treatments		Flower number per cluster		Fruit set %		Yield efficiency (kg/ cm2)		Yield per tree (kg)	
Tree shape	tree spacing m	2002	2003	2002	2003	2002	2003	2002	2003
Vase shape	5x5	9.250	9.500	15.000	16.250	0.179	0.176	48.350	49.580
Vase shape	5x4	8.750	9.000	13.110	13.950	0.168	0.169	43.380	46.030
Vase shape	4x4	8.000	8.500	12.500	13.730	0.168	0.168	39.420	40.330
Espalier form	5x5	11.750	12.000	18.750	19.750	0.188	0.188	33.420	35.450
Espalier form	5x4	11.500	11.750	16.570	17.890	0.188	0.185	31.300	33.580
Espalier form	4x4	10.750	11.000	16.080	17.430	0.186	0.185	31.230	32.150
L.S.D. at 0.05		0.927	0.774	0.360	0.590	0.017	0.017	2.233	2.020

Tabel (5): Effect of different training system and tree spacing on fruit qulaity of " Le Conte" pear trees during 2002 and 2003 seasons.

Treatments		Fruit weight (gm)		Fruit length (cm)		Fruit weidth (cm)		Fruit firmness (pound/cm2)		Acidity %		T.S.S.%		Total sugars %	
Tree shape	spacing m	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
Vase shape	5x5	167.80	170.20	7.70	7.90	6.60	6.80	12.43	12.30	0.43	0.44	12.60	12.70	9.10	9.20
Vase shape	5x4	160.30	165.30	7.40	7.50	6.40	6.50	12.20	12.10	0.41	0.42	12.30	12.60	8.80	8.90
Vase shape	4x4	152.90	155.50	6.75	7.10	6.10	6.20	12.00	11.90	0.40	0.41	12.20	12.30	8.70	8.80
Espalier form	5x5	145.40	148.40	6.50	6.70	5.90	6.00	11.90	12.00	0.36	0.36	13.00	13.10	9.50	9.60
Espalier form	5x4	143.30	146.40	6.50	6.60	5.80	5.90	11.80	11.90	0.35	0.35	12.90	12.90	9.40	9.50
Espalier form	4x4	142.40	144.40	6.40	6.60	5.60	5.70	11.60	11.70	0.35	0.35	12.85	12.90	9.20	9.30
L.S.D. at 0.05		3.67	3.74	0.30	0.22	0.18	0.45	0.17	0.20	0.02	0.02	0.25	0.15	0.29	0.29

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الملخص العربى

تأثير طريقتين تربية وثلاث مسافات زراعة على سلوك أشجار الكمثرى صنف ليكونت

*وصفى ماهر عبد المسيح- **آمال محمود السجينى- **ملكه صبحى نعيمه
* محطة بحوث البساتين بالنوبارية- البحيرة.
**محطة بحوث البساتين بالصبحية – الاسكندرية
معهد بحوث البساتين- مركز البحوث الزراعية- مصر

أجريت هذه الدراسة خلال عامى (٢٠٠١-٢٠٠٢) (٢٠٠٢-٢٠٠٣) على أشجار الكمثرى صنف ليكونت والمنزرعة فى محطة بحوث البساتين بالنوبارية لتقييم نوعين من التربية (الكاسية و على أسلاك) وثلاث مسافات زراعة (٥×٥ ، ٥×٤، ٤×٤ متر) وقد أوضحت النتائج مايلى:

١. تفوقت الأشجار المرباة بالطريقة الكأسية وعلى مسافة زراعة ٥×٥ متر فى المجموع الخضرى من حيث مساحة مقطع الجزع و طول النموات الحديثة وزيادة المساحة الورقية وحجم الاشجار بينما أعطت الأشجار المرباة على أسلاك ومسافة زراعة ٤x٤م أقل القيم فى القياسات السابقة فى كلا من موسمين الدراسة.

٢. تفوقت الأشجار المرباة على اسلاك فى الثلاث مسافات الزراعة فى محتوى الاوراق من الكلورفيل و عدد الازهار لكل عنقود ونسبة عقد الثمارو بعض صفات جودة الثمار (نسبة المواد الصلبة الذائبة ونسبة السكريات الكلية) وذلك خلال عامى الدراسة.

٣. ادت التربية الكاسية على مسافة ٥×٥ م يليها ٥×٤ م الى زيادة محتوى الأوراق من العناصر الكبرى (النيتروجين والبوتاسيوم والفوسفور والكالسيوم والماغنسيوم) والعناصر الصغرى (زنك- منجنيز- حديد).

٤. حققت الاشجار المرباه بالتربية الكأسية على ثلاث مسافات زراعة زيادة معنوية فى محصول الاشجار وجودة الثمار (متوسط وزن الثمرة- ابعادها- النسبة المئوية للحموضة- صلابة الثمار) بالمقارنه بالاشجار المرباه على اسلاك.

٥. يتضح من نتائج هذه الدراسة إن أفضل تربية لأشجار الكمثرى صنف ليكونت هى الطريقة الكأسية على مسافة زراعة (٥×٥ م يليها ٥×٤ م).