

EFFECT OF TRAINING AND SPACING ON ANNA APPLE TREES

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Abstract

The vegetative and reproductive growth, of Anna apple trees grafted on MM 106 and under two training systems, cordon and vase shape, were put under study. Cordon system were divided into Oblique at (1.25X0.60 m), and Cordon at three tree spacing (1.25X2.0;3.0X3.0 and 4.0X4.0 m). Vase shape was at the same later three spacing.

Oblique cordon, the high plant density, is a new technique of planting, yielded highest production (25.2 to 32.5 ton per feddan.)

Cordon with 3.0X3.0 m tree spacing, which gave the largest tree, its yield per tree (around 18.7kg) with production feddan (around 8.8 ton).

Vase shape with 2.0X1.25 m tree spacing, gave moderate yield tree (12.5 to 14.9Kg), while it gave a high yield per feddan (21.0 to 25.0 ton). On the other hand, Vase shape with 4.0 X 4.0 m spacings tree, induced good vegetative growth but lowest yield per feddan (4.3 to 5.7 ton).

Vase shape under any spacing gave fruits with slightly better quality better quality than those obtained by Cordon systems.

INTRODUCTION

Apple is one of the most important fruits of the world. Recently, in Egypt, apple trees have been extensively planted in more than 70,000 feddans. Most of this area planted with Anna apple cultivar which gives yearly more than 403 thousand ton (Anonymous 1997). High-density planting has been an important development of recent decades, which had led to increased productivity. Much attention has been given to controlling the balance between growth and fruit production in high-density planting. Although semi-dwarfing rootstock (i.e. MM. 106) is used for controlling growth, cultural techniques such as pruning and orchard design have an influence on tree development.

Canopies can be modified by tree training to control tree spacing and orchard density. Cripps et al., (1975) postulated that apple production per tree during the first three years of bearing was greatest of moderate spacing (450-500 trees per hectare). They told that high-density up to 1637 tree per hectare, produced less fruit per tree, but more per hectare, while maximum spacing (256-300 tree per hectare) were less efficient. Tattini and Tazzari

(1990) studied three planting densities (13333, 6666 and 3333 trees per hectare) and their effects on vegetative growth they indicated that high density of plantation gave less tree size.

The importance of light in relation to flowering and yield was studied by Cain, (1972) and Jakson (1980) who postulated that tree volume is important for light distribution, small trees having better light than large voluminous trees in which the radiation is very low in the inner parts.

Growth of the apple tree is regulated by winter pruning, but summer pruning may be usefu as well. Shoot growth can be reduced by summer pruning (Marini and Barden 1982 Rom and Ferree, 1984 and Taylor and 1984

Robinson and Lakso, (1989) stated that horizontal canopies suffer from a shaded under side and excessive vegetative vigour. Vertical planar canopies have good light exposure on both sides of the canopy, but have vertical stacking of fruiting branches leading to loss of vigour in the bottom of the tree.

The present study is concerned with the importance of tree shape and spacing on the vegetative growth, flowering, yield and fruit characters of Anna apple tree grafted on MM. 106.

MATERIALS AND METHODS

The present investigation was carried out at Nobaria Horticultural Research Station, El-Behira Governorate, during two successive seasons, (1995-1996) and (1996-1997), on Anna apple trees budded on MM. 106. Trees were planted in 1988 to study the effect of two training systems (Cordon systems and Vase shape), Cordon systems were divided into oblique at (1.25X0.6 m), Furthermore Cordon at three tree spacing (1.25 X 2.5, 3.0 X 3.0 and 4.0 X 4.0 m). Vase shape was at the same later three spacing. Trees were selected nearly equal and treated with normal agricultural practices. Nine trees were taken for each treatment (three trees for each replicate), totaling sixty threes. The complete randomized design arranged and following records were taken : vegetative growth (including shoot length, shoot diameter, number of branches, size of tree and trunk circumference above and below bud union), flowering detes, fruit set, yield per tree and feddan. Fruit characters including physical properties fruit weight gm., fruit size ml., fruit dimensions (heiht and diameter in cm.), and chemical properties (T.S.% by hand refractometer and Juice acidity) Skin colour was estimated by matching with colour chart, (Robert, 1938).

1. Cordon systems

In Cordon system posts of iron are set at 3.5 m. spacings, within row, the post is 2 m above soil surface, and with 3 parallel wires stretched between the posts. The bottom wire was stretched tightly at a height 70 cm soil surface and the others at 60 cm. spacings.

1. *Oblique*

At planting, grafted seedling were planted at an angle of 45° to the soil level. Rows run from north to south to facilitate even growth and the distance between trees was 60 cm and between rows 125 cm. No pruning was necessary after planting except pinching the tip. Side shoots were shortened to 10 cm during the winter. About mid-July cut back all mature laterals growing directly from the main stem to five centimeter. The secondary growth in late summer from shoots pruned in July was cut back in October to one bud. In winter, dry shoots, and crowded shoots were removed (Anonymous, 1974).

2. *Cordon*

At planting, the main leader were left unpruned, side shoots were shortened to a bud, about 90 cm. from the base. Only one branch was unpruned which was used to fill the end of row space. In the second winter, lateral shoots arising from the central leader were pruned to 80cm long. Shoots arising from pruned laterals were cut back to their bases at next winter. The main leader was not pruned unless growth has been weak.

II. *Vase shape*

At planting, grafted seedling were cut about 70 cm. above the soil surface. In the second winter, three to four primary branches, radiating from the center at about 30-35 cm from bud union were select. This process was repeated at second season as lateral branches. This system was used to allow light penetration to all parts of the tree by tre by removing shaded, weak and narrow angle branches.

Treatments

1. Oblique cordon with (1.25x0.6 m) tree spacing.
2. Vase shape canopy with (2.0 x 1.25 m) tree spacing.
3. Cordon with (2.0 x 1.25 m) tree spacing.
4. Vase shape canopy with (3.0 x 3.0 m) tree spacing.
5. Cordon with (3.0 x 3.0 m) tree spacing.
6. Vase shape canopy with (4.0 x 4.0 m) tree spacing.

7. Cordon with (4.0 x 4.0 m) tree spacing. Data were statistically analysed according to Snedecor and Cochran (1990), and L.S.D. test was used for comparison between treatments.

RESULTS AND DISCUSSION

Vegetative growth

Table 1 represents the vegetative growth of Anna apple cultivar in both seasons (95-96 and 96-97) for different orchard systems. Cordon and vase shape with (4x4m.) tree spacing induced the highest shoot length and thickest diameter, while Oblique gave shortest shoot length and thinnest diameter. Number of branches were highest in the first season comparing with the second season. Cordon with (4.0 x 4.0 m) tree spacing gave highest number of branches ranging between 5.30 to 7.33, Oblique gave lowest number ranging between 2.33 to 3.00 Cordon with (3.0 x 3.0m) tree spacing gave the vigorous tree during the two seasons (12.00 and 15.00m³), Oblique was the smallest (2.19 and 3.03 m³). The increase in trunk circumference above bud union was high for Cordon with (4.0 x 4.0 m) tree spacing. The Cordon and Vase shape with 4.0x4.0 m spacing gave the highest value of trunk increase circumference bellow bud union, while the lowest was recorded for Oblique above and bellow bud union (Table 1 and Fig 1). These results are in line with Lambard et al., (1985) and Tattini and Tazzari (1990) who demonstrated that trunk cross-sectional area and tree size depend on planting density.

Flowering and production

The effect of different systems on flowering dates for Anna cultivar in both seasons is shown in Table 2, and Fig 2 there were no differences in time of flowering of the Cordon and Vase shape with 4.0 x 4.0 m spacing tree (22 Feb and 24 Feb) in that order of seasons. Oblique cordon flowering date began before any treatment (7 Feb. and 15 Feb. in the two seasons, respectively). It appears from Table 2 that the percentage of fruit set was highest for Cordon with 4 x 4 m spacing tree (31.63% and 25.02%). The lowest percentage was for Oblique (16.80% 14.43%) in the two successive seasons. As regards to the yield per tree for the all treatment, it was found that the highest was that of Vase shape with 4.0x4.0 m spacing tree (16.30 and 21.60 Kg/tree) the lowest one for Oblique (4.50 and 5.80 Kg/tree) in the two seasons. These results are confirmed by many workers, since Cripps et al., (1975), demonstrated that high-density produced less fruit per tree but more per hectare. Jackson and Polmer (1977) told that shading apple limbs reduced flower formation and fruit-set in the following season.

Table 2. Effect of different training systems and spacing methods on flowering date, fruit set and yield per tree during (95-96) and (96-97) seasons.

Treatments		Flowering dates		Fruit set at 29 Feb 95-96		Fruit set at 29 Feb.96-97		Yield per tree (Kg.)	
tree shape	Distance	95-96	96-97	Mean Angle	%	Mean Angle	%	95-96	96-97
Oblique	1.25x 0.60 m	7 Feb.	15 Feb.	24.10	16.80	22.34	14.43	4.50	5.80
Vase shape	2.0x1.25 m	10 Feb.	17 Feb.	26.47	19.83	24.26	16.83	12.50	14.90
Cordon	2.0x 1.25 m	11 Feb.	18 Feb.	26.22	22.37	25.57	18.63	9.90	12.70
Vase shape	3.0x 3.0 m	19 Feb.	22 Feb.	31.09	26.70	28.34	22.53	15.80	19.40
Cordon	3.0x 3.0 m	19 Feb.	23 Feb.	32.37	28.67	29.27	23.74	16.70	20.80
Vase shape	4.0x 4.0 m	22 Feb.	24 Feb.	32.31	28.60	29.33	24.07	16.30	21.60
Cordon	4.0x4.0 m	22 Feb.	24 Feb.	37.24	31.63	30.02	25.02	16.50	20.10
L.S.D at 0.05				0.543		0.850		0.86	0.95

Concerning the effect of Cordon system and Vase shape on different density plantation on number of tree per feddan, yield per tree (Kg) and yield per feddan (Ton) are presented in Table 3 and Fig 2. Although the yield per tree for Oblique was low (4.5 and 5.80 Kg), it gave the highest yield per feddan (25.200 and 32.480 for two successive seasons. On the other hand Cordon and Vase shape with (4.0 x 4.0m) spacing tree gave the highest yield per tree ranging between 16.30 to 21.6 Kg, the yield per feddan was very low and ranging between 4.266 to 5.659 ton in the same two seasons. It could be due to that number of tree per feddan was 5600 tree for Oblique while 262 tree for Cordon and Vase shape with 4.0 x 4.0 m spacing tree.

Cumulative yield was positively related to plant density. The general economical implications of such high density plantings are discussed by Goedegebure (1976, 1984), who calculated that an increase of the plant density in a range between 2200 and 4400 trees per hectare led to more yield per hectare.

Fruit characters

Tables 4 and 5 show the characteristics of mature fruits produced by all treatments. Statistical analysis revealed that significant differences occurred in weight and size of fruit. The highest values were obtained of Vase shape with (3.0 x 3.0 m) spacing of tree in the two seasons. Fruits of all treatments had diameter, high and circumference very close except Oblique which the values tended to decrease, in the two seasons. Statistical significant variation were detected in fruit firmness for fruits of all treatments. In the first season, it could be noticed that Cordon and Vase shape with all spacing gave values ranged between 10.2 to 11.6 pound/inch² in the second season Vase shape and Cordon at 4.0 x 4.0 m spacing gave the highest firmness (15.4, 15.3 pound/inch², respectively).

Statistical analysis shows insignificant differences for total soluble solids (T.S.S) and acidity of fruits produced by all treatments in the second season, in first one, T.S.S and acidity were closely related in fruits from all treatments.

The two systems of training gave a good red colour for fruits, it may be due to good light distribution which enhance anthocyanine formation. These observations are in agreement with those of Heinicke (1968) as he mentioned that there is strong linear relationship between apple fruit redness and light. Brown (1975) reported that all aspects of fruit colour is complex and often confusing because the expression of this characters can be affected by the state of maturity, by the general climate and by micro-climate within the area of the tree.

Table 3. Effect of different training systems and spacing methods on number of tree per feddan, yield per tree and yield per feddan in (95-96) and (96-97) seasons.

Treatments		Number of tree/ feddan	yield/ tree (Kg)		Yield / feddan (Ton)	
tree shape	spacing		95-96	96-97	95-96	96-97
Oblique	1.25x 0.60 m	5600	4.50	5.80	25.200	32.480
Vase shape	2.0 x 1.25 m	1680	12.50	14.90	21.000	25.032
Cordon	2.0 x 1.25 m	1680	9.90	12.70	16.632	21.336
Vase shape	3.0 x 3.0 m	466	15.80	19.40	7.363	9.040
Cordon	3.0 x 3.0 m	466	16.70	20.80	7.782	9.693
Vase shape	4.0 x 4.0 m	262	16.30	21.60	4.271	5.659
Cordon	4.0 x 4.0 m	262	16.50	20.10	4.323	5.266
L.S.D at 0.05			0.86	0.95	0.65	0.44

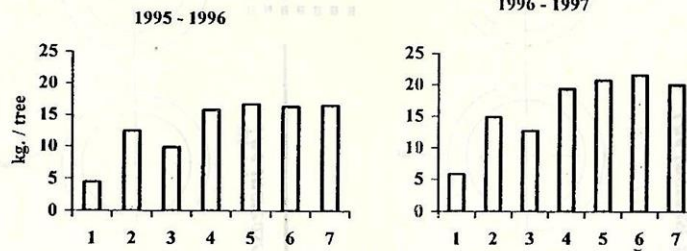
Table 4. Effect of different training systems and spacing methods on fruit characters in (95-96).

tree shape	Treatments		Fruit weight (gm)	Fruit size (cm ³)	Fruit diameter (cm)	Fruit height (cm)	Fruit circumference (cm)	Fruit firmness (pound/cm ²)	T.S.S %	Acidity %	Fruit Colour
	Spacing										
Oblique	1.25x0.60m		107.0	150.3	5.7	6.1	19.2	10.6	11.3	0.413	Currant Red 821
Vase shape	2.0x1.25m		127.3	178.7	6.7	6.7	21.7	10.2	10.5	0.320	Turky Red 721
Cordon	2.0x 1.25m		122.3	170.7	6.6	6.6	21.1	10.3	11.5	0.382	Turky Red 721
Vase shape	3.0x3.0m		143.3	181.3	6.3	6.7	20.3	11.6	10.7	0.427	Currant Red 821/3
Cordon	3.0x3.0m		127.3	170.0	6.4	6.8	21.0	10.3	10.2	0.423	Currant Red 821/1
Vase shape	4.0x 4.0m		135.0	166.3	6.2	6.8	21.8	11.5	10.3	0.427	Cherry 722
Cordon	4.0x4.0m		128.7	159.3	6.5	6.6	21.0	11.0	10.2	0.413	Turky Red 721/2
L.S.D at 0.05			6.5	8.2	0.25	0.24	0.57	1.00	0.71	0.061	

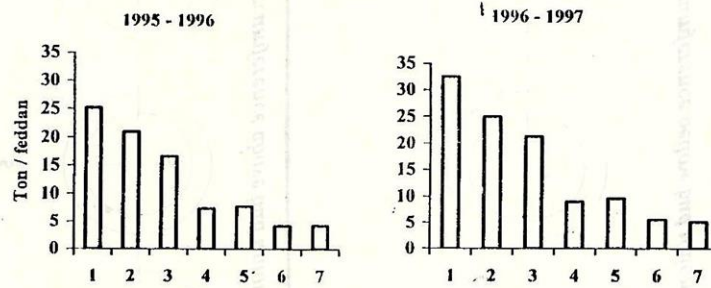
Table 5. Effect of different training systems and spacing methods on fruit characters in (96-97).

Treatments		fruit weight (gm)	Fruit size (cm ³)	fruit diameter (cm)	fruit height (cm)	fruit cir. (cm)	fruit firmness (Pound/cm ²)	T.S.S %	Acidity %	Fruit colour
tree shape	spacing									
Oblique	1.25x0.60m	6.70	81.0	5.0	5.0	16.4	12.9	10.4	0.455	Current Red 821
Vase shape	2.0x1.25m	88.7	99.7	5.8	5.9	18.9	13.7	10.2	0.408	Turky Red 721
Cordon	2.0x1.25m	81.7	95.0	5.8	6.0	18.4	13.8	9.1	0.443	Turky Red 721
Vase shape	3.0x3.0m	103.3	115.6	5.8	5.8	18.3	13.5	10.4	0.409	Currant Red 821/3
Cordon	3.0x3.0m	79.0	89.7	5.8	5.7	19.1	12.5	10.5	0.479	Currant Red 821/1
Vase shape	4.0x4.0m	101.4	110.9	5.8	5.9	18.7	15.3	9.8	0.460	Cherry 722
Cordon	4.0x4.0m	91.7	102.5	5.6	5.5	18.0	15.4	9.8	0.118	Turky Red 721'2
L.S.D at 0.05		5.9	6.8	0.50	0.50	0.87	0.63	N.S	N.S	

- | | |
|---------------|--------------|
| 1. Oblique | 1.25 X 0.6 m |
| 2. Vase shape | 2.0 X 1.25 m |
| 3. Cordon | 2.0 X 1.25 m |
| 4. Vase shape | 3.0 X 3.0 m |
| 5. Cordon | 3.0 X 3.0 m |
| 6. Vase shape | 4.0 X 4.0 m |
| 7. Cordon | 4.0 X 4.0 m |

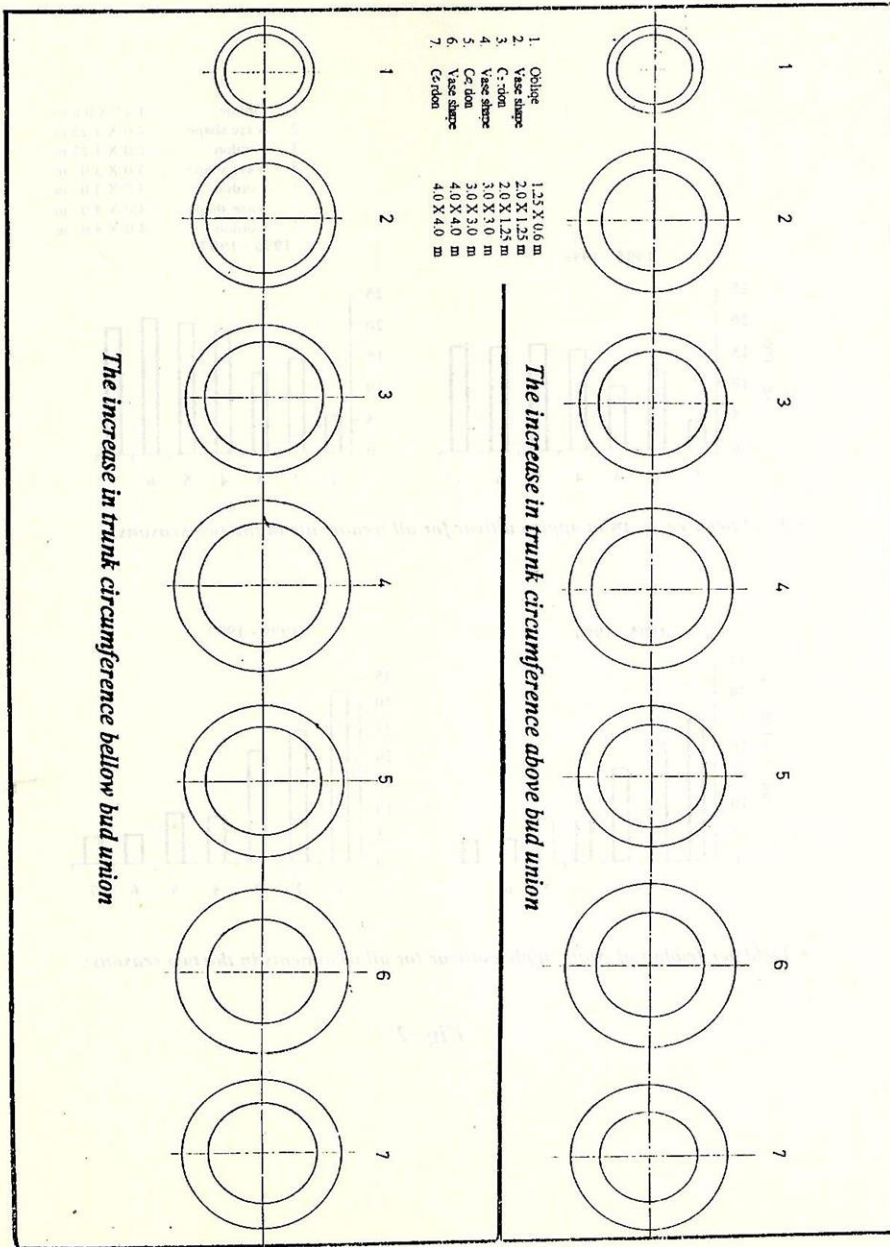


• Yield per tree of Anna apple cultivar for all treatments in the two seasons:



• Yield per feddan of Anna apple cultivar for all treatments in the two seasons:

Fig 2



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تأثير بعض طرق التربوية ومسافات الزراعة علي النمو والتزهير والمحصول لأشجار تفاح الأنا

بهان خليل ، عبد الرحمن الشيخ ، علي يسري

معهد بحوث البساتين - مركز البحوث الزراعية - القاهرة - مصر.

أجري هذا البحث في محطة بحوث البساتين بالنوبارية بمحافظة البحيرة خلال عامي الدراسة (١٩٩٥ - ١٩٩٦)، (١٩٩٦ - ١٩٩٧)، وذلك بزراعة شتلات التفاح الأنا المطعومة علي أصل مالنج ميرتون ١٠٦ في فبراير ١٩٨٨ علي مسافات مختلفة هي :

١- التظم الكردونية :

١ - الزراعة الكردونية الكثيفة (٠.٦ - ١.٢٥ متر).

٢ - الزراعة الكردونية علي ثلاث مسافات

أ - ١.٢٥ x ٢ متر

ب - ٣ x ٣ متر

ج - ٤ x ٤ متر

١- الطريقة الكأسية المفتوحة وكانت علي ثلاث مسافات

أ - ١.٢٥ x ٢ متر

ب - ٣ x ٣ متر

ج - ٤ x ٤ متر

وقد تمت دراسة البيانات التالية :

× النمو الخضري ويشمل (طول الأفرع وأقطارها - عدد الأفرع - حجم الشجر - محيط الجذع فوق منطقة التطعيم وأسفل منطقة التطعيم).

× النمو الزهري ويشمل (موعد التزهير - نسبة العقد - المحصول لكل من الشجرة والفدان).

× الصفات الثمرية (الصفات الطبيعية - الصلابة - نسبة المواد الصلبة الكلية - نسبة الحموضة - التلوين).

وقد أوضحت النتائج :

× أعطت الزراعة الكردونية الكثيفة أعلى محصول للفدان (٢٥.٢ - ٣٢.٥ طن) نتيجة لزيادة عدد الأشجار في الفدان.

× أعطت الزراعة بالطريقة الكردونية علي سلك علي مسافة ٣ x ٣ متر أكبر حجم للأشجار وكان محصول الثمار في الفدان ٨ طن تقريباً.

- × أعطت الطريقة الكأسية المفتوحة علي مسافة $2 \times 1,25$ متر محصول متوسط للشجرة (١٢ - ١٥ كجم) بينما كان محصول الثمار للفدان (٢١ - ٢٥ طن) أما في حالة المسافات الكبيرة 4×4 متر أعطت نمو خضري جيد وكان محصول الفدان يتراوح بين $٤,٣ - ٥,٧$ طن.
- × كانت الصفات الثمرية في طريقتي التربية (النظم الكربونية - والطريقة الكأسية المفتوحة) متقاربة.