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INFLUENCE OF CANOPY FORM ON GROWTH AND FRUITING OF ANNA APPLE TREES

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ABSTRACT

Three training systems and tipping shoots were applied to two-year-old Anna apple trees budded on MM.106 rootstock. Their effects on growth were proved significantly by increasing full sunlight received by trees. Moreover, central leader received a significantly higher percentage than open vase trees. Contrarily, tipping significantly reduced these values, while directions insignificantly affected this parameter. On one- and two-year-old shoots, the control recorded the highest value of dormant buds, whilst open vase recorded the lowest. Tipping significantly reduced these values for two-year-old shoots. Training and tipping significantly increased the percentage of vegetative buds on one -and two-year-old shoots: Tipping increased spur numbers. Open vase trees recorded a significantly high mean individual leaf area. Tipping significantly increased leaf area. Insignificant effects for training and tipping on total number of leaves were recorded though differences were noticed. Central leader recorded the highest values while open vase recorded the least. Both, training and tipping application significantly increased average fruit weight at maturity. A significant reduction in fruit firmness at maturity was recorded in trained trees; central leaders produced firmer fruits compared to open vase trees. Tipping reduced fruit firmness. Both training and tipping increased TSS(%), open vase trees.

recorded the highest values. Training and tipping reduced acidity in the fruits. Open vase fruits recorded the lowest values. Open vase trees produced fruits with the highest total sugar content.

Key words: *anna, apple, central leader, light, training, vase, vegetative.*

1. INTRODUCTION

Pruning severity affects light transmission,(Ferree *et al.*, 1989). They reported that following severe dormant pruning, the Lincoln canopy trees had high light transmission value, while, following only light pruning, a very dense canopy developed with very low transmission values. Canopy light penetration was high in branch-thinned trees but low in those whose branches were pruned to 20 cm (Takishita *et al.*, 1995). The efficiency of converting light energy into fruit was the highest for the Y-trellis/ M. 26 system when compared to slinder spindle/ M. 9, central leader on M. 9 inter stock/ MM. 111 and central leader/ M. 7 (Robinson *et al.*, 1993). Shading inhibited annual increment in total leaf area/ tree (Chen and Lenz, 1997 b). Chen and Lenz (1997 a) also stated that trees trained to Y-trellis had more vigorous vegetative and reproductive growth and a heavier fruit load compared to spindles. Ferree *et al.*, (1989) reported that total leaf area was found to be altered due to training systems applied. It was found that unpruned Lincoln canopy had the greatest leaf area compared to spindle bush, pruned Lincoln canopy and 3 wire palmate trellis while the central leader system tended to have the lowest. Y-trellis and full light treatments had a larger average fruit size and heavier fruits (Chen *et al.*, 1998). Also, fruits had higher TSS, starch, glucose, fructose, sucrose, sorbitol and total non-structural carbohydrate content.

2. MATERIALS AND METHODS

This study was carried out during the two successive seasons of 1997 and 1998 on Anna apple cultivar. Two-year-old trees were used at the start of the study. They were planted in the sandy loamy soil at El-Khatattba, Monoufiah Governorate. Both "Anna" and the pollinizer " Golden Dorsette ", were budded on the semi - dwarfing rootstock MM. 106. Three training systems and tipping were under investigation. The experiment was laid out in a completely randomized design with twelve single trees as replicates for each canopy form. The training systems under investigation were as follows:

2. 1. Canopy form

2. 1. 1. Control: Young apple trees were left to grow without interrupting their natural growth pattern, but excessive vigor and water sprouts were removed in December (1996). Similarly, the same practice was followed in the following dormant season (December 1997). Control trees were divided into equal groups. In the first group, heading back was not applied to any shoots during the dormant pruning. In the second, heading back was applied to all shoots during the dormant pruning.

2. 1. 2. Central leader system: The characteristics of the central leader include a single, central trunk, from which all structural branches arise, a pronounced conical shape, with separate and distinct tiers of scaffold limbs. To maintain leaders dominance, a single leader was chosen in each tree and all the competing shoots were removed after transplanting trees from the nursery in February 1996 (Forshey *et al*., 1992). In December 1996 (when training practices were applied for the first time), the first tier of scaffold limbs was selected about 45 cm above the ground. Selected limbs had wide crotch angles, separated vertically on the trunk by 10–20 cm, and were oriented towards different quadrants. During the following dormant season (December 1997), a second tier of limbs was selected, about 60 cm above the first one. In this tier, limbs were selected so that they intersect the quadrants occupied by scaffold in the tier below. If two scaffold limbs are to be above one another, a minimum distance of 100 cm should be left in between. A selected scaffold limbs had a basal diameter smaller than that of the trunk at the point of attachment (Tehrani *et al*.,1989). Trees of this group were divided into two sub - groups equally where heading back was applied to one of these groups.

2. 1. 3. Open vase system: in February 1996, after transplanting the young trees from the nursery to the orchard, the trunk was headed-back to about 60 – 80 cm above the ground level. In December 1996, 3 – 6 scaffold limbs, almost similar in length, were selected and headed-back to 30 – 50 cm. Selected limbs were oriented outwards with an angle exceeding 45°, and did not originate from the same point in order to avoid breakage when carrying heavy crop of fruits in the future. Lateral shoots were left to grow on these limbs as long as they were not oriented inwards, so that the centers of the trees were always hollow. Later, in December 1997, a number of laterals were selected on each scaffold limb. It was put into consideration that all shoots oriented inwards or causing crowding were eliminated. Half the number of trees in this treatment were untipped, and the other half were tipped.

Three trees from each treatment were devoted for studies. On each tree, four two-year-old shoots of similar development, one in each direction were selected and tagged before bud opening. Similarly, four one- year old shoots were selected and tagged.

2. 2. Field Studies

2. 2. 1. Amount of full sunlight received by trees: Each tree was divided into four quadrants (East, South, West and North). Measurements were taken at each sampling position within individual tree using a Digital Light Meter model DLM_2. For each canopy region, three spot measurements were recorded using a horizontally held sensor, one at the base, one at the middle, and the third at the tip of the labeled shoot. Values statistically analyzed were the mean value of these three readings. No attempts were made to avoid sunfleks. All readings were taken between 1000 and 1400 h (that is solar noon ± 2 h). These light mission readings were made in mid June.

2. 2. 2. Phenological characteristics

2. 2. 2. 1. Vegetative and dormant buds (%); were counted in early February on one- and two-year-old shoots and the percentage of each type was calculated in relation to the total number of buds .

2. 2. 2. 2. Number of spurs; were counted in early January on labeled two-year-old shoots.

2. 2. 2. 3. Mean individual area (cm^2); leaf samples were gathered from tree periphery, from each treatment, in late June. Each sample consisted of 100 leaf, and the average individual leaf area was expressed in cm^2. A portable area meter model L – 3000 was used.

2.2. 2. 4. Total number of leaves per tree; was counted and recorded at fruit maturity.

2. 2. 3. Fruiting

The most suitable harvesting date was estimated to be 114-121 days after full bloom for Anna apples (Abd El-Aziz *et al.*, 1985). Mature apple fruits were picked after the total color reached about 50 %, fruit firmness was about 12 lb/inch^2, and total soluble solids (T.S.S.) was about 11 % (ADS, 1982).

2. 2. 3. 1. Yield (Kg/ tree); was determined at maturity.

2. 3. Fruit characteristics at maturity

2. 3. 1. Average fruit weight (g)

2. 3. 2. Fruit firmness (Lb./ inch^2); was measured at opposite side of fruits in the equatorial region using a penetrometer with an 11.1 mm diameter head (Warrington *et al.*, 1996).

2. 3. 3. Total soluble solids (TSS %). were measured by using a hand refractometer.

2. 3. 4. Titrable acidity (%): It was determined in terms of anhydrous malic acid percentage (A. O. A. C., 1960).

2. 3. 5. Total sugars (g/ 100g fresh weight): were determined colourimetrically in an ethanolic extract using phenol sulphuric acid method as described by Dubois *et al.*, (1956).

2. 4. Data analysis

The design used was randomized complete block in factorial arrangement with three replicates. Analysis of variance was performed according to Gomez and Gomez (1984), and the differences between means were detected using L. S. D. at 0.05.

3. RESULTS AND DISCUSSION

3. 1. Effect of training system, tipping application and direction on the amount of full sunlight received by trees.

Results shown by Figure (1) present the amount of full sunlight (%) as affected by training in the first and second growing seasons after training application. It was noticed that the control recorded significantly the lowest values in both, the first (23.29) and second (27.33) seasons, which were below the light critical level for photosynthesis (30 %) (Ferree and Baritt, 1997). Meanwhile, values recorded for central leader and open vase trees in both seasons after training were significantly different (47.16, 40.33 and 48.04, 40.67, respectively). Central leaders recorded values that were 102.5 % and 75.8% more than those recorded by controls in both seasons. Similarly, open vase trained trees, recorded 73 % and 49 % more than controls.

This result is in disagreement with Hampson *et al.* (1997) who stated that light interception did not differ significantly between systems.

Regardless of the training system applied, tipping significantly decreased the amount of full sunlight received by trees, in both seasons of investigation. These results are in harmony with those of Takishita *et al.* (1995) who reported that canopy light penetration was high in branch-thinned trees compared to those whose branches were tipped.

3. 2. Effect of training system and tipping application on phenological characteristics

3. 2. 1. Percentage of dormant buds on one-year-old shoots

Results in Table (1) reveal that training system insignificantly affected the percentage of dormant buds on one-year-old shoots in the first growing season after training application, in contrast with the latter where the effect was significant. In this season, untrained controls recorded the highest value, which may be due to the excessive shade inside the canopy, which agrees with the results reported by Asada and Ogasawara (1996) who mentioned that increased shade increases the degree of apical dominance of lower branches.Open vase trees recorded the least. Tipping had an insignificant effect on this parameter.

Season 1997 **Season 1998**

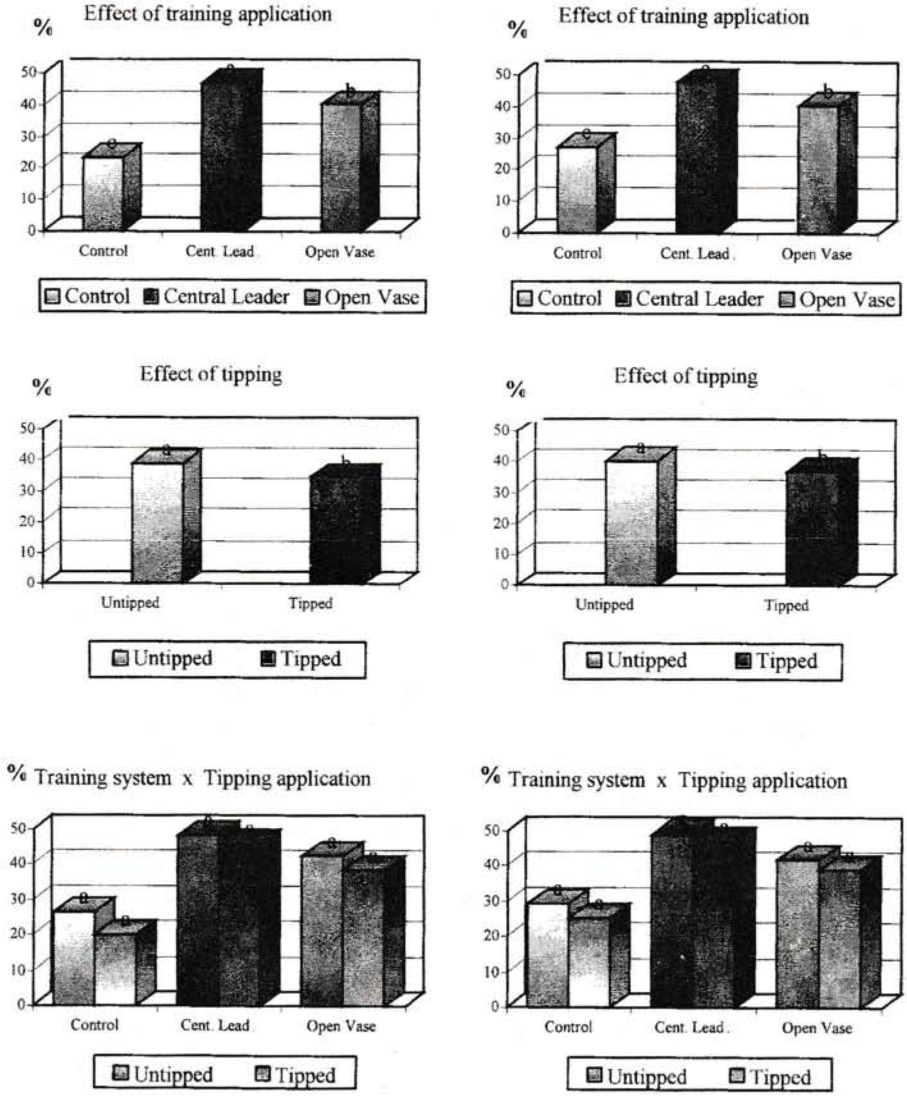

Fig.(1) : Effect of training system and tipping application on the percentage of full sunlight received by trees.

Table (1): Effect of training system and tipping application on the percentage of dormant buds on one-year-old shoots.

Training System (A)	First growing season after training application (1997)			Second growing season after training application (1998)		
	Tipping (B)		**Mean (A)**	Tipping (B)		**Mean (A)**
	Untipped	Tipped		Untipped	Tipped	
Control	34.33	38.16	**36.24**	36.90	38.78	**37.84**
Central L.	36.95	36.02	**36.49**	36.83	36.08	**36.46**
Open Vase	37.24	34.62	**35.93**	36.24	35.12	**35.68**
Mean (B)	**36.17**	**36.26**	-	**36.66**	**36.66**	-

LSD at 0.05	A	B	A * B
Season 1997	N.S.	N.S.	2.624
Season 1998	1.634	N.S.	N.S.

3. 2. 2. Percentage of dormant buds on two-year-old shoots

Results in Table (2) show that this parameter was insignificantly affected by training system in the first growing season, in contrast with the second season where the effect was significant. The highest bud activity was present in open vase trained trees followed by central leaders and untrained controls, respectively. In the second growing season after training application, open- vase trained trees recorded a significant low dormant bud percentage compared to controls, meanwhile, the difference between control and central leaders and controls was insignificant. Tipping significantly decreased the percentage of dormant buds on two-year-old shoots.This effect was confirmed in both growing seasons. This may be explained that auxins from terminal buds inhibit lateral growth (apical dominance), and the removal of these buds by tipping releases lateral buds from dormancy (Forshey *et al.*, 1992).

3. 2. 3. Percentage of vegetative buds on one-year-old shoots

Results in Table (3) demonstrated that training significantly increased this percentage in the first and second seasons after training but differences between central leader and open vase were insignificant. This may be due to the reduced apical dominance resulting from better light penetration into trained tree canopies,

Table (2): Effect of training system and tipping on the percentage of dormant buds on two-year-old shoots.

Training System (A)	First growing season after training (1997)			Second growing season after training (1998)		
	Tipping (B)		**Mean (A)**	Tipping (B)		**Mean (A)**
	Untipped	Tipped		Untipped	Tipped	
Control	52.20	51.58	**52.02**	50.12	49.58	**49.85**
Central L.	51.26	48.26	**49.86**	50.46	46.88	**48.67**
Open Vase	51.56	47.74	**49.65**	49.90	47.33	**48.61**
Mean (B)	**51.67**	**49.35**	-	**50.16**	**47.93**	-

LSD at 0.05	A	B	A * B
Season 1997	N.S.	2.127	N.S.
Season 1998	1.19	1.593	N.S.

which is in harmony with what Asada and Ogasawara (1996) reported. Tipping increased the percentage of vegetative buds on one-year-old shoots in both growing seasons. This may be due to the reduced number of mixed buds formed in tipped trees, which is in harmony with what Mika *et al*., (1992) reported in this regard.

Table (3): Effect of training system and tipping on the percentage of vegetative buds on one-year-old shoots.

Training System (A)	First growing season after training (1997)			Second growing season after training (1998)		
	Tipping (B)		**Mean (A)**	Tipping (B)		**Mean (A)**
	Untipped	Tipped		Untipped	Tipped	
Control	21.54	22.36	**21.95**	20.38	21.96	**21.17**
Central L.	24.01	23.36	**23.68**	22.96	24.27	**23.62**
Open Vase	21.43	25.54	**23.48**	21.92	25.62	**23.77**
Mean (B)	**22.29**	**23.75**	-	**21.76**	**23.95**	-

LSD at 0.05	A	B	A * B
Season 1997	1.346	1.098	1.903
Season 1998	1.272	1.038	N.S.

3. 2. 4. Percentage of vegetative buds on two-year-old shoots

Results in Table (4) show that trained trees recorded significantly higher values in both growing seasons after training application, compared to untrained trees. Meanwhile, insignificant differences were noticed between central leader and open vase trained trees in both seasons. Similarly, regardless of training system applied, tipping led to a significant increase in the percentage of vegetative buds on two-year-old shoots. This result is in line with the findings of Forshey *et al.* (1992), who reported that routine heading of shoots stimulates shoot growth.

Table (4): Effect of training system and tipping on the percentage of vegetative buds on two-year-old shoots.

Training System (A)	First growing season after training (1997)			Second growing season after training (1998)		
	Tipping (B)		**Mean**	Tipping (B)		**Mean**
	Untipped	Tipped	**(A)**	Untipped	Tipped	**(A)**
Control	36.69	40.35	**38.52**	40.32	43.60	**41.96**
Central L.	39.78	43.	**41.40**	43.22	46.16	**44.69**
Open Vase	38.84	45.16	**42.00**	43.04	47.05	**45.04**
Mean (B)	**38.44**	**42.48**	-	**42.19**	**45.60**	-

LSD at 0.05	A	B	A * B
Season 1997	2.438	1.990	N.S.
Season 1998	N.S.	1.290	N.S.

3. 2. 5. Number of spurs on two-year-old shoots

Results presented in Figure (2) show that training application increased the numbers of spurs on two-year-old shoots compared to untrained controls. It also shows that central leaders had more spurs compared to open vase trees. In the first growing season after training application, and regardless of tipping, the mean number of spurs recorded for controls was 5.4, while it was 8.8 for central leaders and 7.6 for open vase trees. As for the values recorded in the second season, a similar trend was noticed, but with a slight increase in values which is most probably due to tree age. Regardless of training system applied, tipping significantly increased the number of spurs on two-year-old shoots. This effect was confirmed in the second season after training application. In the first season, tipping control trees

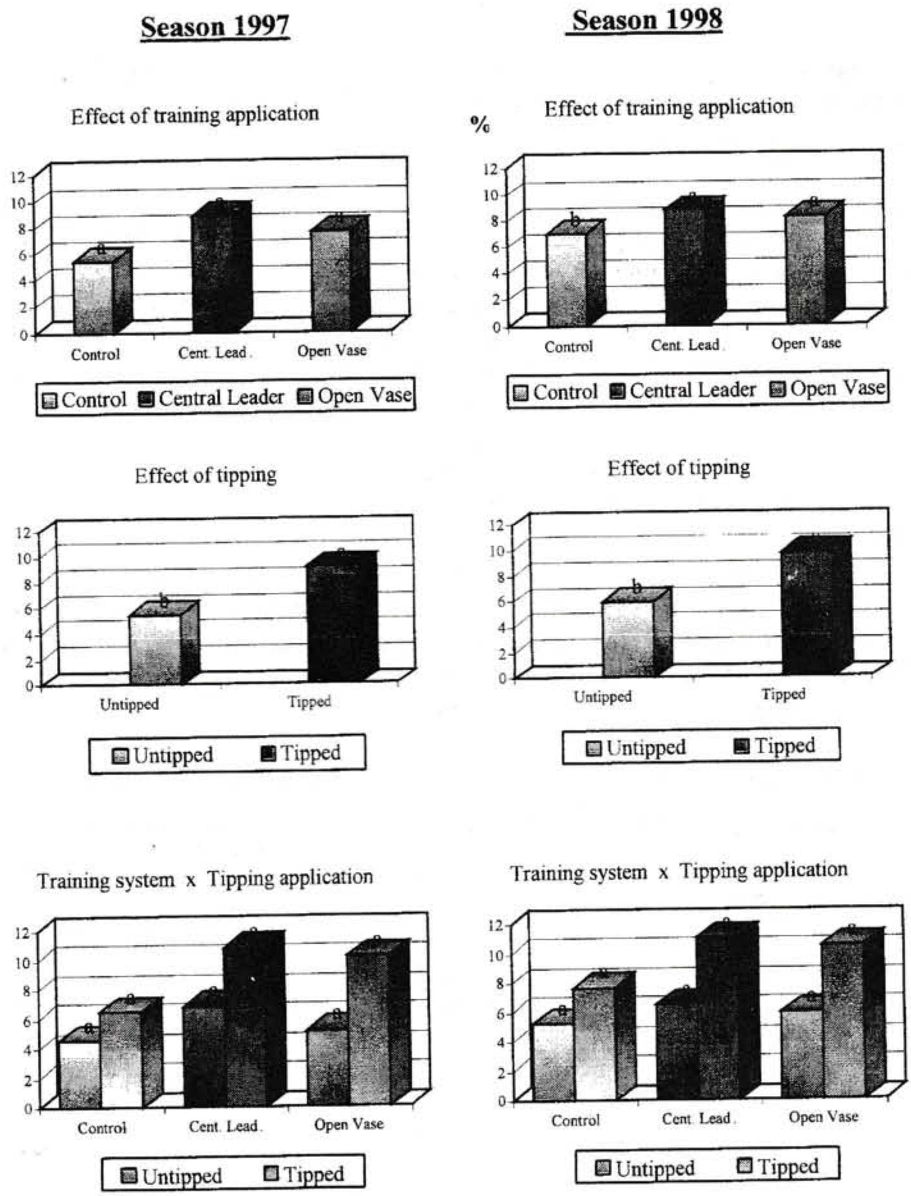

Fig.(2): Effect of training system and tipping application on the number of spurs produced on two-year-old shoots.

increased the number of spurs from 4.5 to 6.4, while in central leaders, spur number increased from 6.8 to 10.8, and in open vase trees it increased from 5.2 to 10.2.

3. 2. 6. Mean individual leaf area (cm^2)

Results presented in Table (5) demonstrate that, in both seasons, training application had a significant impact on this parameter, where open vase trained trees recorded a significantly high value compared to controls, and central leader was in between, with insignificant differences from control. Regardless of the training system, tipping increased the mean individual leaf area. This increase was significant in the first growing season after training application, and was insignificant in the second season. Similarly the interaction of training system with tipping significantly affected individual leaf area in the first season and insignificantly in the second season. In the first season, compared to controls and open vase, the untipped central leaders recorded a significantly low value. In tipped trees, open vase recorded the highest value followed by central leaders and controls, respectively, where neither controls and central leaders, nor, central leaders and open vase showed significant differences.

Table (5): Effect of training system and tipping application on mean individual leaf area (cm^2).

Training System (A)	First growing season after training application (1997)			Second growing season after training application (1998)		
	Tipping (B)		**Mean (A)**	Tipping (B)		**Mean (A)**
	Untipped	Tipped		Untipped	Tipped	
Control	25.09	24.39	**24.74**	25.48	25.95	**25.72**
Central L.	21.61	25.90	**23.76**	23.93	25.40	**24.67**
Open Vase	25.75	27.86	**26.81**	26.21	27.49	**26.85**
Mean (B)	**24.15**	**26.05**		**24.87**	**26.28**	

LSD at 0.05	A	B	A * B
Season 1997	1.696	1.384	2.398
Season 1998	1.504	N.S.	N.S.

3. 2. 7. Total number of leaves produced by trees

Training system, tipping, and the interaction between them insignificantly affected the total number of leaves produced by trees (Table 6). In both growing seasons, and regardless of training application, tipping increased the total number of leaves. Similarly, training application increased leaf number, with central leaders producing more leaves than open vase trees.

In trained trees, tipped ones produced more leaves than the untipped, in contrast with untrained controls, where the untipped produced more leaves than tipped ones.

Table (6): Effect of training system and tipping application on the total number of leaves produced by trees.

Training System (A)	First growing season after training (1997)			Second growing season after training (1998)		
	Tipping (B)		**Mean (A)**	Tipping (B)		**Mean (A)**
	Untipped	Tipped		Untipped	Tipped	
Control	1613	1516	**1565**	3707	3183	**3445**
Center L.	1607	1639	**1623**	2607	4107	**3357**
Open Vase	1476	1589	**1533**	2924	3264	**3094**
Mean (B)	**1565**	**1581**	-	**3079**	**3518**	-

LSD at 0.05	A	B	A * B
Season 1997	N.S.	N.S.	N.S.
Season 1998	N.S.	N.S.	N.S.

3. 3. Effect of training system and tipping application on fruit characteristics at maturity

3. 3. 1. Average fruit weight (g)

A significant increase was recorded in trained trees in both growing seasons as shown in Table (7). Moreover, open vase produced significantly heavier fruits compared to central leader trained trees. This result is in harmony with the findings of Forshery *et al.* (1992), who reported that the zone that received less than 30 % of light produced smaller fruits, which is the case in untrained controls. As for the effect of tipping, it significantly increased fruit weight in both seasons.

Table (7): Effect of training system and tipping on average fruit weight (g) at maturity.

Training System (A)	First growing season after training (1997)			Second growing season after training (1998)		
	Tipping (B)		**Mean (A)**	Tipping (B)		**Mean (A)**
	Untipped	Tipped		Untipped	Tipped	
Control	136.24	145.13	**140.69**	129.24	146.98	**138.1**
Center L.	149.96	151.99	**150.98**	137.20	157.62	**147.4**
Open	153.87	156.99	**155.43**	153.49	160.98	**157.2**
Mean (B)	**146.69**	**151.37**	-	**139.98**	**155.19**	-

LSD at 0.05	A	B	A * B
Season 1997	1.508	1.231	2.132
Season 1998	3.219	2.628	4.552

3. 3. 2. Fruit firmness (Lb./ inch^2)

Training application significantly affected fruit firmness (Table 8). Moreover, central leader and open vase harvested fruits, showed a significant difference in both growing seasons after training application; a reduced fruit firmness was noticed in open vase harvested fruits. This result is in accordance with Nawar *et al.* (1996) who reported a negative correlation between Anna fruit size and firmness. Moreover, taking into consideration light conditions of trained and untrained trees, our results are considered in agreement with the findings of Heinicke (1966) who reported that light exposed apples are less firm than those from heavily shaded areas. A significant decrease in fruit firmness was recorded in the first growing season after training as a result of tipping, while it was insignificant in the second season. This could be due to the increased fruit size caused by tipping, which is a result of reduced fruit number and reduced competition between fruits.

3. 3. 3. Fruit TSS (%)

Results in Table (9) show that training in general led to a significant increase in TSS, specially for the open vase system, compared to untrained control trees, in both growing seasons after training application. This result came in line with the findings of Fallahi and Simons (1996) who stated that trees with high yields

Table (8): Effect of training system and tipping application on fruit firmness (Lb./ inch^2) at maturity.

Training System (A)	First growing season after training application (1997)			Second growing season after training application (1998)		
	Tipping (B)		**Mean (A)**	Tipping (B)		**Mean (A)**
	Untipped	Tipped		Untipped	Tipped	
Control	14.66	14.66	**14.66**	14.59	14.48	**14.53**
Central L.	14.49	14.12	**14.31**	14.00	14.13	**14.07**
Open Vase	13.67	13.32	**13.50**	13.67	13.52	**13.60**
Mean (B)	**14.27**	**14.04**	-	**14.09**	**14.04**	-

LSD at 0.05	A	B	A * B
Season 1997	0.027	0.058	0.101
Season 1998	0.087	N.S.	0.123

produced smaller fruits with lower soluble solid concentration. The present results also show that open vase recorded a significantly high value compared to central leader. Moreover, a negative correlation was noticed between fruit firmness and TSS (%) in each training system. As for the effect of tipping on this parameter, it led to a significant increase in obtained values, in both growing seasons. This confirms the negative correlation between fruit firmness and TSS (%) for the same treatments.

Table (9): Effect of training system and tipping application on fruit TSS (%) at maturity.

Training System (A)	First growing season after training (1997)			Second growing season after training (1998)		
	Tipping (B)		**Mean (A)**	Tipping (B)		**Mean (A)**
	Untipped	Tipped		Untipped	Tipped	
Control	12.60	12.83	**12.71**	12.46	12.91	**12.68**
Central L.	12.60	13.10	**12.85**	12.90	12.95	**12.92**
Open Vase	13.31	13.48	**13.39**	13.11	13.32	**13.21**
Mean (B)	**12.83**	**13.14**	-	**12.82**	**13.06**	-

LSD at 0.05	A	B	A * B
Season 1997	0.096	0.078	0.136
Sea1998	0.092	0.074	N.S.

3. 3. 4. Fruit titratable acidity (%)

Results presented in Table(10) show that open vase trained trees produced fruits with a significantly lower acidity compared to controls and central leader trained trees, in both growing seasons. Meanwhile, comparing central leader harvested fruits, to those harvested from controls showed that there was no similar trend followed in both seasons. Here, it is worth mentioning that open vase harvested fruits showed an increased size and TSS (%) and a decreased fruit firmness and acidity, compared to control and central leader harvested fruits. As for the effect of tipping on fruit acidity at maturity, acidity was significantly reduced in fruits harvested from tipped trees.

Table (10): Effect of training system and tipping application on fruit titratable acidity (%) at maturity.

Training System (A)	First growing season after training (1997)			Second growing season after training (1998)		
	Tipping (B)		**Mean (A)**	Tipping (B)		**Mean (A)**
	Untipped	Tipped		Untipped	Tipped	
Control	0.66	0.65	**0.65**	0.67	0.64	**0.65**
Central L.	0.66	0.64	**0.65**	0.66	0.64	**0.66**
Open Vase	0.64	0.62	**0.63**	0.65	0.62	**0.63**
Mean (B)	**0.65**	**0.64**	-	**0.66**	**0.63**	-

LSD at 0.05	A	B	A * B
Season 1997	0.006	0.005	N.S.
Season 1998	0.007	0.005	N.S.

3. 3. 5. Fruit total sugars (g/ 100 g fresh weight)

Results in Table (11) show that applying open vase training system led to asignificant increase in fruit total sugars when compared to untrained controls in both growing seasons after training application, and central leaders in the first season only. Meanwhile, in the second season, insignificant differene was recorded between controls and central leaders. This means that the increased TSS (%) of open vase could be to a certain extent, due to the accumulation of total sugars. That is why open vase harvested fruits showed a negative correlation between fruit firmness and each of TSS and total sugars.
Meanwhile, this correlation was not well expressed in central leader

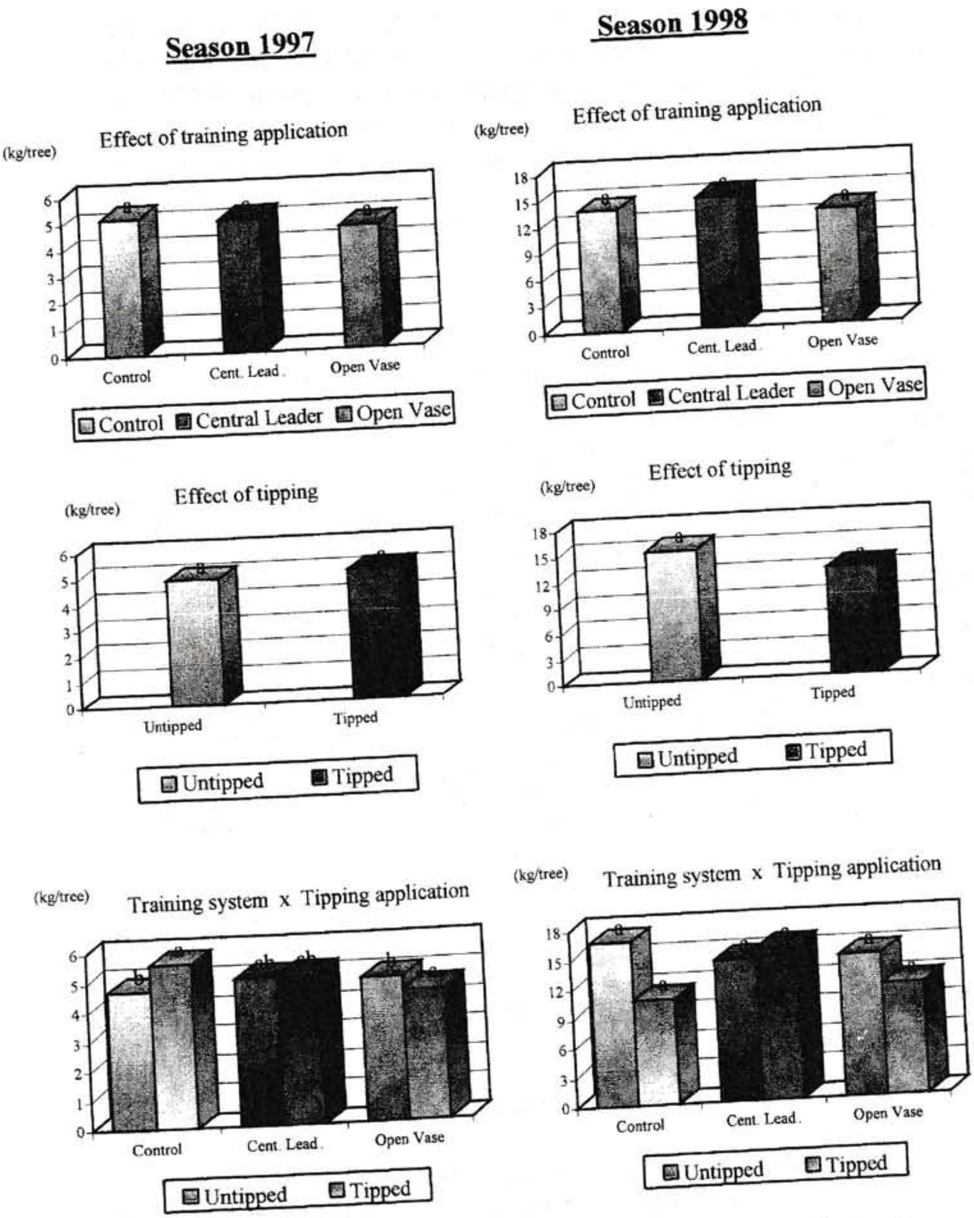

Fig. (3): Effect of training system and tipping application on yield (kg/tree).

harvested fruits, where accumulation of TSS could be due to the accumulation of other chemicals besides sugars. Obtained results are in harmony with the findings of Wagenmakers and Tazelaar (1999) who stated that sunshine during the season correlated very well with sugar content. Obtained results also showed a significant increase in sugar content of tipped trees harvested fruits, compared to those harvested from untipped ones. This means that the increased TSS (%) of fruits harvested from tipped trees could be to a certain extent, due to the high sugar content.

Table (11): Effect of training system and tipping application on fruit total sugars (g/ 100 g fresh weight) at maturity.

Training System (A)	First growing season after training (1997)			Second growing season after training (1998)		
	Tipping (B)		**Mean (A)**	Tipping (B)		**Mean (A)**
	Untipped	Tipped		Untipped	Tipped	
Control	5.35	5.67	**5.51**	5.31	5.48	**5.39**
Central L.	5.41	5.55	**5.48**	5.40	5.59	**5.49**
Open Vase	5.65	5.65	**5.65**	5.59	5.73	**5.66**
Mean (B)	**5.47**	**5.62**		**5.43**	**5.60**	

LSD at 0.05	A	B	A * B
Season 1997	0.030	0.024	0.042
Season 1998	0.207	0.168	N.S.

3. 3. 6. Fruit Yield (Kg/ tree)

Results in Figure (3) show that neither training system nor tipping significantly affected fruit yield (Kg/ tree) in both growing seasons after training application. These results are in agreement with the findings of Hampson *et al.* (1997) who found that training system did not affect yield in the first four years.

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تأثير شكل المسطح الخضرى على نمو وإثمار أشجار التفاح"أنا"

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ملخص

درست ثلاث طرق للتربية وتطويش الأفرع عمر سنتين لأشجار التفاح صنف "أنا" المطعومة على الأصل م م ١٠٦ ، أدت تربية الأشجار إلى زيادة نفاذية الضوء داخل المسطح الخضري وكانت الإضاءة داخل الأشجار المرباة بطريقة القائد الوسطى اكبر من تلك المرباة بالطريقة الكاسية وعلى العكس قلل التطويش معنويا من نفاذية الضوء ، لم يظهر للاتجاهات تأثير معنوي على هذه الصفة. كانت نسبة البراعم الساكنة على الأفرع عمر سنة وسنتين لأشجار المقارنة الاعلى بينما كانت الأقل ما يمكن على الأشجار المرباة بالطريقة الكأسية . ادى التطويش الى اعلى نسبة من البراعم الساكنة على الأفرع عمر سنتين كما زادت نسبة البراعم الخضرية معنويا بأجراء التربية والتطويش على الأفرع عمر سنة وسنتين . أدى التطويش إلى زيادة نسبة الدوابر المتكونة على الأفرع عمر سنتين. سجلت الأشجار المرباة بالطريقة الكأسية أعلى متوسط لمساحة الورقة ، كذلك أدى التطويش الى زيادة مساحة الورقة ولم يظهر تأثير معنوى لكل من التربية والتطويش على عدد الأوراق الكلى للشجرة على الرغم من وضوح الفروق فى القيم المتحصل عليها. سجلت الأشجار المرباة بطريقة القائد الوسطى أعلى القيم بينما كانت أقلها فى تلك المرباة بالطريقة الكأسيه. أدت التربية والتطويش إلى زيادة متوسط وزن الثمار عند اكتمال النمو و قللت التربية بوجه عام من الصلابة وكانت صلابة ثمار الأشجار المرباة بالقائد الوسطى أعلى من مثيلاتها فى الأشجار المرباة بالطريقة الكأسية ، قلل التطويش من صلابة الثمار عند اكتمال النمو ، إلا ان نسبة المواد الصلبة الذائبة الكلية زادت بأجراء التربية والتطويش وسجلت ثمار الطريقة الكأسية أعلى القيم ، وعلى العكس قللت التربية والتطويش من حموضة الثمار ،سجلت ثمار أشجار الطريقة الكأسية اقل القيم كما سجلت أعلى نسبة للسكريات الكلية

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