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PERFORMANCE OF SOME GRAPE CULTIVARS UNDER DIFFERENT TRELLISING SYSTEMS

BY

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ABSTRACT

This investigation was conducted to study the influence of some trellising systems on yield and its components, physical and chemical characteristics of berries, morphological characteristics of vegetative growth, coefficient of wood ripening, weight of prunings, trunk volume, cane content of total carbohydrates and coefficient of bud fertility on three cultivars; Superior, Flame Seedless and Thompson Seedless. The investigation included four trellis systems; Spanish Parron (SP), Gable (G), Y shape (Y) and double (T). The grapevines were eight years old grown in a sandy loam soil and irrigated by the drip irrigation system, spaced at 1.5 X 3.5 meters apart in Gable, Y and T system, while they were 3.0 X 3.5 meters apart in Spanish Parron system. The vines were cane pruned in Superior and Thompson seedless with 60 buds/m row, while spur pruned in Flame seedless with a load of 40 buds/m row.

The results showed that both Spanish Parron and Gable were the best trellising systems, since they achieved the best yield and its components as well as the best physical properties of bunches, improved the physical and chemical characteristics of berries and ensured the best vegetative growth parameters, dynamics of wood ripening, coefficient of bud fertility and total carbohydrates of canes in comparison with the other trellising systems.

INTRODUCTION

The grape is a climbing plant which requires supports and careful training and pruning to yield well. There are many designs of trellising systems which are different in height, width and length. A trellis should provide the framework for a leaf canopy that maximizes light interception by addressing the excess of vine vigor and canopy shade through increasing the renewal zone and expanding the length of the canopy through both increased vine spacing and canopy division. Trellis design is an important factor that influences physiological and management aspects of the grapevine (Ende Van den, 1984, Smart *et al.*, 1982 and 1985 and Smart, 1988).

The essential trellis requirements for high quality are exposed leaf surface area must remain high without layering of leaves, grape bunches should be well-positioned to avoid being too shaded or exposed to strong sunlight and the size of old wood must be developed progressively depending on vigor in order to regulate the water flow and increase the reserves close to bunches (Carbonneau, 1999).

The type of trellis system is known to have large effects on shoot growth, fruit composition and, crop yields of grapevines (Shaulis 1980; Smart *et al.* 1985;

Smart and Smith 1988; Kliewer *et al.*, 1988; Reynolds and Wardle 1994 and Abd El-Ghany and Marwad 2001). The design in which excessive shading of fruits by foliage occurs has generally reduced fruit quality and yield. A two wire (Geneva Double curtain) trellis design increased Concord grape yields by as much as 90% relative to single wire (Kniffin) design as a result of improved leaf and shoot exposure (Shaulis *et al.*, 1966). Improved fruit exposure with four and six wire trellis system increased Cabernet sauvignon yields by 45% and 48% respectively relative to the yield from a standard two-wire (Steinhauer and Bowers 1979). Also, Ezzahouani and Williams 2003 on Ruby seedless grapevines found that triple design had greater shoot growth, leaf area and pruning weights than the double design.

Owing to the fact that grapevines are light-loving plants, effort of researchers have been focused on searching for trellising systems that can provide the vine with sufficient sunlight necessary for raising the efficiency of photosynthesis. The shape of a trellis system for grapevines should support and spread longer shoots, which are more exposed to the sun. Sun light is the environmental factor that is most frequently not fully utilized by grape growers to maximize, crop yields. By manipulating vine width and height through different trellising systems, growers can greatly increase the total amount of light intercepted by foliage per unit area of the vineyard and thereby increase photosynthetic capacity. High light intensity is required for maximum photosynthesis (Kliewer 1973).The yield of Crouchen grape was increased up to 30% due to trellis widening from 0.3 up to 1.4 m (May *et al.*, 1976). Also, Baeza *et al.*, 2000 recorded that vineyard net photosynthesis was highest in vertical trellis which had a higher canopy surface area (SA).

Bud differentiation, fruit ripening and wood maturation are closely related to seasonal management operations such as shoot positioning (Smart, 1985).

Light interception by a grapevine depends on leaf area and distribution of the leaves which are affected by the shape of the plant. Low light intensity from veraison to harvest was found to reduce berry weight, TSS and total acidity (Kliewer 1971). Exposed fruit had higher concentrations of glucose and fructose (Crippen and Morrison 1986). Direct exposure to can lead to high temperature which can reduce berry weight (Kliewer 1971) delay sugar accumulation (Kliewer and Weaver 1971) or cause slow color development (Bergqvist *et al.*, 2001). Canopy morphology and spatial leaf distribution will affect solar radiation interception, light penetration inside the canopy, sun-flecks, canopy and vineyard microclimate, flower induction, leaf area index, growth of shoots, leaves and cluster, grape maturation and carbohydrate partitioning (Ollat and Carbonneau 1992 and Mabrouk *et al.*, 1997). Dokoozlion and Kliewer (1995) stated that the trellis is often improperly utilized resulting in an excessive fruit zone shading under vigorous conditions and inefficient vineyard design in low-vigor situation: A greater number of trellis systems have been utilized in order to better match trellis configuration to the anticipated vine vigor (Dokoozlian *et al* 1998). Several systems incorporate canopy division (either horizontal or vertical) and shoot positioning. These modifications are designed to improve production efficiency by reducing canopy density, as well as increasing solar interception by the canopy surface and sunlight penetration into the canopy interior (Smart 1973 & 1985).

The amount of old wood retained on a grapevine can also affect both yield and fruit composition. Studies in Austria (Konlechner 1961) and Bulgaria (Mihailov 1980) and (Stoev & Dobreva 1976) among others suggested that the additional perennial wood obtained from the use of high trunks could lead to increasing yield and achieving higher soluble solids in the fruit. Weaver and Kasimatis (1975) stated that increasing trunk height and the use of cross arms increased yield and enhanced fruit maturity. Koblet and Perret (1982) demonstrated that old wood on three *V. vinifera* cultivars acted as a carbohydrate reservoir and may have been responsible for higher yield, cluster weights and fruit soluble solids. Increasing the functional photosynthetic surface area of the vine by increasing the reservoir for photosynthates through the retention of significant quantities of old wood, may have major impacts on vine performance and fruit composition (Hassan *et al.*, 1991). The photosynthesis must be considered as the key element of plant physiology (Stoev and Slavtcheva 1982). The physiological activity can be an important factor for growth, yield and quality. The organic matter produced by plants is the results of the physiological activity (Guardiola and Garcia 1990).

The objective of this investigation is to study the impact of four different trellising systems; Spanish Parron, Gable, Y shape and double (T) in three cultivars; Superior, Flame Seedless and Thompson Seedless on vegetative growth, yield and fruit composition.

MATERIALS AND METHODS

This study was conducted for two successive seasons (2001/2002 and 2002/2003) in a private vineyard located at Cairo-Alexandria road, on three cultivars; Superior, Flame seedless and Thompson seedless to evaluate four trellising systems; Spanish Parron (SP), Gable (G), Y shape (Y) and double T shape (T). The chosen grapevines were eight years old grown in a sandy loam soil and irrigated by the drip irrigation system, spaced at 1.5 X 3.5 meters apart at Gable, Y and T systems, while they were spaced 3.0 X 3.5 meters apart at Spanish Parron system (Table, 1).

Diagrammatic representation of these systems is shown in Figure (1).

The vines were cane pruned in Superior and Thompson Seedless with bud load of 60 buds/m row, whereas they were spur pruned in Flame Seedless with 40 buds/m row.

Table (1)

Trellis system	Space Vine X Row (m)	Height of vine trunk (m)	Height of wires bearing fruiting canes (m)	No. of used wires
Spanish Parron (SP)	3.0 X 3.5	1.90	2.10	12
Gable (G)	1.5 X 3.5	1.60	1.80	10
Y shape (Y)	1.5 X 3.5	1.35	1.55	8
Double T shape (T)	1.5 X 3.5	1.20	1.25	4

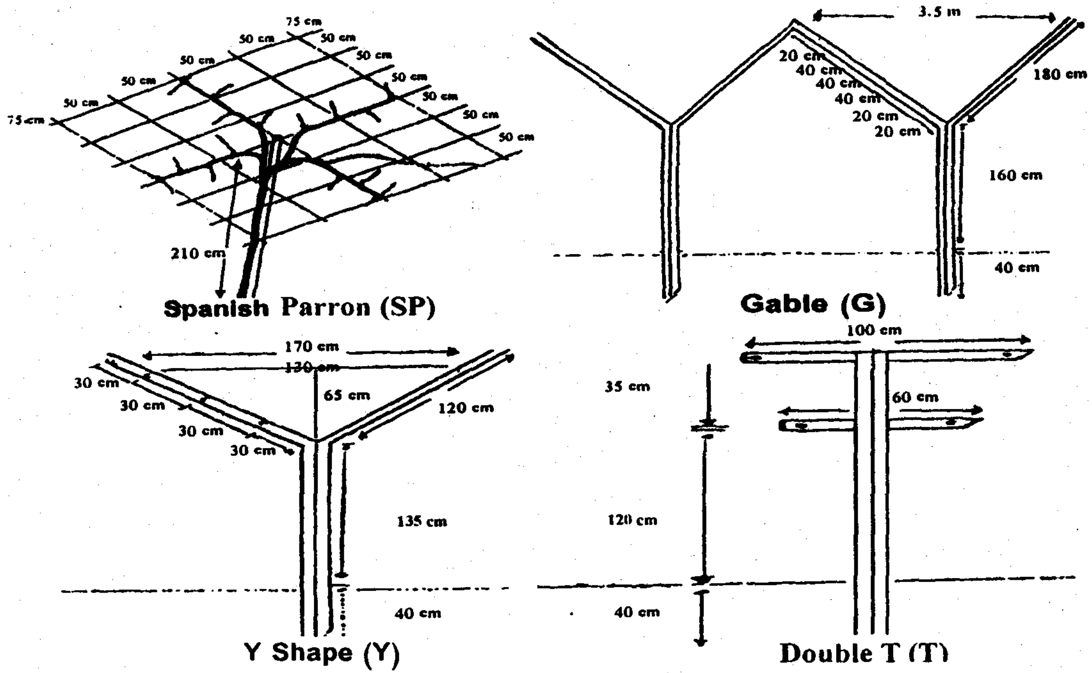


Figure (1): A diagram showing the applied systems of trellis

Vines of each cultivar according to the export procedures were treated as recommended (bunch thinning, berry thinning by GA or manual).

The vines chosen included 12 for replicate and three replicates were used for each system in each cultivar under study.

The following parameters were adopted to evaluate the tested treatments:-

At veraison stage, two vines were specified for sampling. A representative sample of 20 berries from the apical, middle and basal portions of the bunch was picked from each vine every week. Total soluble solids% (TSS) using a hand refractometer. Total titratable acidity% expressed as tartaric acid according to the (A.O.A.C. 1985) were determined in the juice. Sampling continued for each treatment till TSS reached about 16-17% according to Tourky *et al.* (1995).

1. Yield and physical characteristics of bunches:

Yield/vine was determined by multiplying average number of bunches/vine by average bunch weight.

Representative random samples of six bunches/vine were harvested at maturity stage. The following characteristics were determined: average bunch weight (g), bunch width and length (cm) and number of berries per bunch.

2. Physical and chemical characteristics of berries:

Berry weight (g), berry size (cm^3) and berry dimensions (length and diameter) (cm). Total soluble solids in berry juice (T.S.S.) (%) by hand refractometer and total titratable acidity as tartaric acid (%) (A.O.A.C. 1985), then TSS /acid ratio was calculated. Total anthocyanin content of berry skin (mg/100g fresh weight) was determined according to Husia *et al.* (1965).

3-Vegetative growth parameters and total carbohydrates of the cane (%):

At growth cessation, the following morphological and chemical determinations were carried out on 4 shoots / the considered vine:

1- Average shoots diameter (cm).
2- Average shoots length (cm).
3- Average number of leaves/shoot.
4- Leaf area density expressions:

At various intervals, 10 shoots, randomly chosen from 10 vines within each treatment were used to determine: shoot length, number of leaves and the total number of shoots, then total leaf area per vine (m^2) and canopy leaf area (m^2 leaf area per meter canopy length) were determined according to Dokoozlian and Kliewer (1995). LAI was determined by dividing leaf area per vine (m^2) by the total ground area (m^2) allotted to each vine. The leaf area to canopy area ratio (LA/CA) was calculated by dividing leaf area per vine (m^2) by the ground area covered by the vine canopy (m^2). The latter value was determined by measuring canopy length and width on the vineyard floor. If the canopy failed to reach the vineyard floor, the length and width of the canopy shadow on the ground at solar noon was used for the calculation. LA/SA was determined by dividing leaf area per vine (m^2) by the canopy surface area per vine (m^2). The height and width of both vertical walls as well as the length and width of the top surface of the canopy were recorded near harvest. The measurements revealed that canopy shape was a truncated triangle (Smart, 1973).

5- Coefficient of wood ripening: this was calculated by dividing length of the ripened part of the shoot by the total length of the shoot according to Bouard (1966).
6- Weight of prunings (Kg) at dormancy.
7- Size of old wood (cm^3)

It was estimated just before defoliation. The trunks were divided into cylindrical sections and the divided trunks into (n) sections. To compute trunk volume, the following formula was used:

$$V = \Sigma^n \left(\frac{d_i}{2}\right)^2 . \pi . L_i$$

Where (di) is the diameter of the trunk section with length L_i

8- Total carbohydrates of the cane (%)
At dormancy period, total carbohydrates (%) of canes were determined according to (Smith *et al.*, 1956).

4- Microclimate data:

Microclimate data were weekly recorded during the growing period from fruit set to the harvest time using Scheduler plant stress monitor to determine the average of:-

- Air temperature (C°)
- Crop temperature (C°)
- Relative humidity (%)
- Sunlight intensity (Watt)

These data were taken at the fruit zone

5- Coefficient of bud fertility:

50 buds for each node position (from the first to 12th bud) were examined to determine coefficient of bud fertility. This was calculated by dividing average number of bunches per vine by the total number of buds/vine left at pruning in different trellis systems for the cultivars; Superior and Thompson Seedless grapevines, whereas, Flame Seedless grapevines were examined for each node position (1 to 5) for both seasons respectively according to (Prasad and Pandev, 1969).

6- Statistical analysis:

The complete randomized blocks design was adopted for the experiment. The statistical analysis of the present data was carried out according to the methods described by Snedecor and Cochran (1990). Averages were compared using the new LSD values at 5% level of significance.

RESULTS AND DISCUSSION

For a better understanding of the results obtained, it was found more convenient to report the findings under the following main topics:

- Dynamics of maturity indices at various dates:-

Harvesting indices (TSS% and acidity %) were weekly monitored from veraison till 8/6 in the first season and 11/6 in the second one for Superior and Flame Seedless grapevines. As for Thompson Seedless variety these indices were counted till 6/7 in the first season and 9/7 in the second one.

TSS %

Juice TSS % (Figure 2) increased steadily by time elapsed throughout the considered sampling dates to reach its peak on Jun 8 & Jun 11 for Superior and Flame Seedless grapevines for both seasons respectively. Thompson Seedless grapes reached their peak on Jul 6 & Jul 9 for both seasons respectively. All trellis systems reached or approached a TSS % of 15-16% (maturity index described by Tourky *et al.* (1995) prior to the last sampling date for the three cultivars in both seasons.

Acidity %

Juice acidity % (Figure 2) decreased gradually throughout the period beginning from veraison stage for all trellis systems.

1. Yield and physical characteristics of bunches:

Data in Table (2) show a significant increase in the yield either per vine or per meter row or per Feddan in favour of Gable and Spanish Parron trellis systems as compared with Y and T shape trellis systems in both seasons for the three cultivars under study. The highest yield per vine was found in Spanish Parron trellis system in Superior and Thompson Seedless cvs., while in Flame Seedless cv., Gable trellis system was the highest. However, the difference between Gable and Spanish Parron trellis systems was insignificant in this respect. The increase observed in the yield may be ascribed to the higher number of bunches per vine and the increase in bunch weight observed at the high trellis system. Y shape trellis system was found to have the lowest yield. A significant increase could be detected concerning average bunch weight and number of berries/bunch in Gable and Spanish Parron trellis systems in comparison with Y shape and T shape trellis systems. This by its turn in addition to the higher number of bunches per vine led to the observed increase in the yield per vine.

The effect of trellis systems on bunch dimensions i.e. length and width was statistically insignificant.

These results can be interpreted in view of the fact that bunches of Gable and Spanish Parron trellis systems had a higher degree of light penetration through their canopy as compared with Y and T shape trellis systems (Fig. 3).

In addition, Gable and Spanish Parron trellis systems had higher trunks 1.9 & 1.6 m supported with 12 &10 wires respectively. These factors resulted in a significant increase in the yield as compared to Y and T shape trellis systems which had the trunk of 1.35 & 1.20 m supported with 8 & 4 wires respectively. The results in this connection are in agreement with those obtained by (May *et al.*, 1976, Smart 1985, Reynolds and Wardle 1994 and Kliewer *et al*, 2000), who stated that crop yield of SH and TK2T trellis systems averaged 29 to 55% higher than the VSP system. The three horizontally divided canopy systems (Geneva Double Curtain (GDC), Lyre and V) had the highest crop yields, amounting to 88% higher than the VSP system.

2. Physical and chemical characteristics of berries:

Data in (Table 3) indicated that vines of Gable and Spanish Parron trellis systems had the highest values of berry weight, size and dimensions, i.e. length and diameter as compared to Y shape and T shape trellis systems in both seasons for the three cultivars. The highest parameters measured were detected in case of vines trellised by Spanish Parron trellis system followed by Gable trellis system. T shape trellis system was the lowest one in this respect.

The increment in bunch and berry weight observed in Gable and Spanish Parron trellis systems could be ascribed to the parallel increment observed in the leaf area and the resulted increase in photosynthesis activity of the leaves.

With regard to the chemical characteristics of berries, positive effects attributed to Gable and Spanish Parron trellis systems were evident on TSS and TSS/acid ratio as compared to Y and T shape trellis systems. No significant differences could be detected between all trellis systems as regards acidity (%). Anthocyanin content of berry skin for Flame Seedless was higher for Gable and Spanish Parron trellis systems in both seasons. While, Y shape and T shape trellis systems were shown to have the lowest values in this connection.

The above results show evidently the advantages of applying Gable and Spanish Parron trellis systems where the total amount of light intercepted by foliage per unit area of the vineyard and thereby increased the photosynthetic capacity, resulting in improving the quality of bunches and berries as compared to the Y and T shape trellis systems in which the height and width of the trellis were lower. The results in this respect are in line with those obtained by (Orth and Chambers 1994 and Abd El-Ghany and Marwad 2001), who stated that trellis widening caused an obvious improvement in fruit quality of some grape cultivars.

3- Vegetative growth parameters and total carbohydrates of the cane (%):

Data in (Table 4) show that there were significant differences between the trellis systems concerning the parameters of vine vigor; shoot diameter, shoot length and number of leaves in both seasons for the three cultivars. Spanish Parron and Gable trellis systems which had higher trunks and wider trellis significantly increased these parameters as compared with Y and T shape trellis systems which had lower trunk and width. These results may be attributed to that Spanish Parron and Gable trellis systems allowed vine foliage to increase light interception and reduce canopy density. The results are in line with those obtained by (Weaver and Kasimatis 1975, Orth and Chambers 1994 and Abd El-Ghany and Marwad 2001); the latter noticed that open espalier-type system was more suitable for mechanized canopy management.

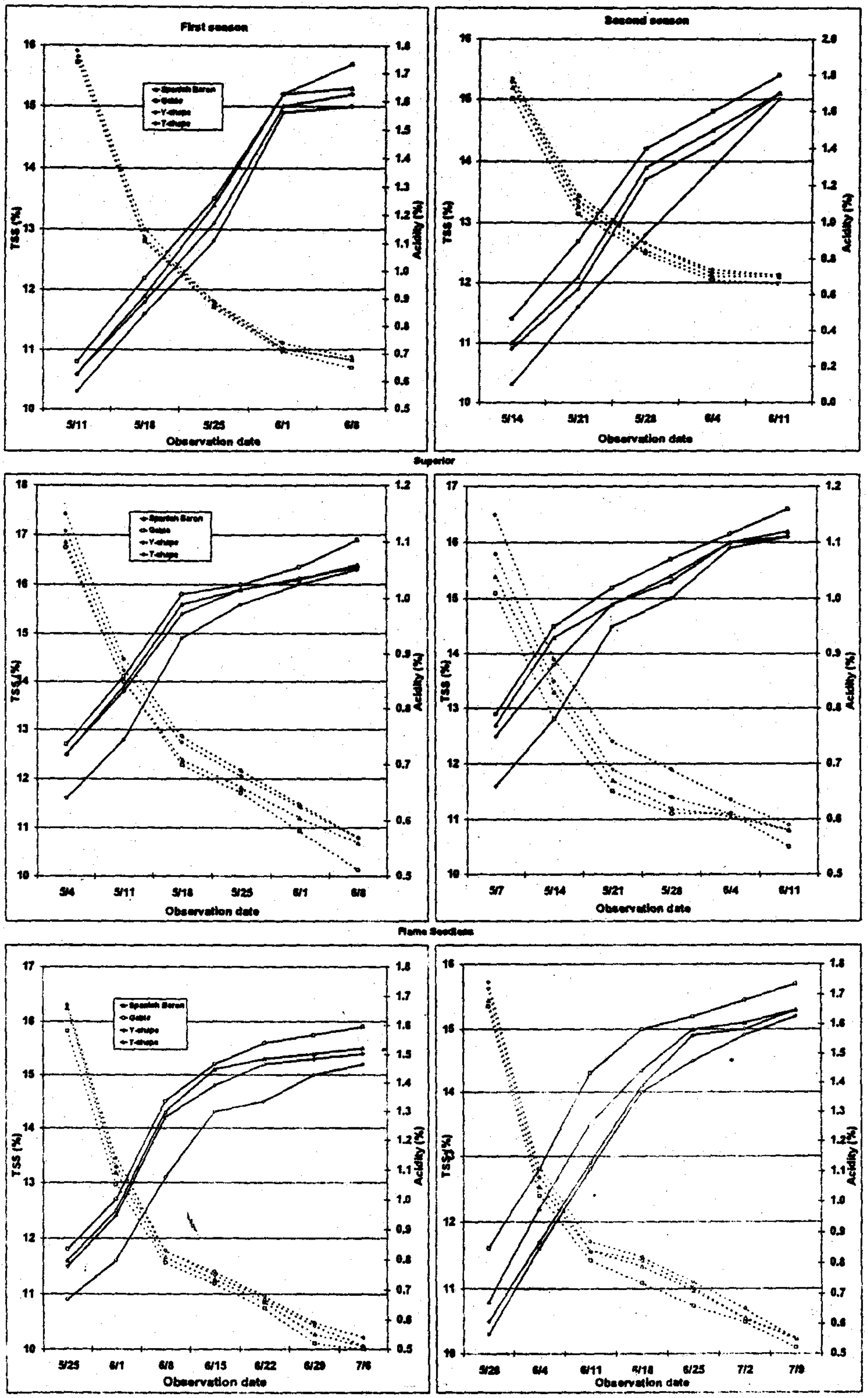


Fig (2): Average weekly TSS and acidity (%) in berry juice as affected by different trellis systems for three cultivars in both seasons

Table (2): Impact of trellis system on the yield and bunch physical characteristics of Superior, Flame Seedless and Thompson Seedless grapevines.

Variety	Trellis system	Yield (kg) per vine	Yield (kg) per meter row	Yield (kg) per Feddan	No. of bunches per vine	No. of bunches per meter row	Bunch weight (g)	Bunch length (cm)	Bunch width (cm)	Number of berries/ bunch
		First season								
Superior	Spanish Baron	26.8	8.9	10730.8	35.1	11.7	764.3	22.6	18.6	125.8
	Gable	13.3	8.9	10667.2	20.0	13.3	666.7	22.5	18.4	114.1
	Y-shape	9.7	6.4	7723.3	18.9	12.6	510.8	22.2	17.9	111.3
	T-shape	8.2	5.5	6549.4	17.4	11.6	470.5	21.9	17.8	103.8
New LSD at (0.05) =		2.1	1.5	1423.2	4.7	N.S.	99.1	N.S.	N.S.	12.7
Flame seedless	Spanish Baron	31.6	10.5	12621.4	43.8	14.6	720.4	21.7	17.1	199.8
	Gable	16.1	10.7	12866.3	24.9	16.6	645.9	21.3	16.8	186.1
	Y-shape	12.0	8.0	9639.0	22.5	15.0	535.5	20.0	16.6	158.7
	T-shape	10.7	7.2	8592.4	20.9	13.9	513.9	19.7	16.5	155.0
New LSD at (0.05) =		1.8	1.1	1127.1	4.8	N.S.	74.9	N.S.	N.S.	17.4
Thompson seedless	Spanish Baron	28.6	9.5	11453.4	37.4	12.5	765.6	24.1	19.5	176.4
	Gable	14.5	9.7	11597.0	21.0	14.0	690.3	23.8	19.4	172.0
	Y-shape	9.9	6.6	7921.4	18.0	12.0	550.1	23.5	19.2	140.4
	T-shape	7.8	5.2	6265.7	16.3	10.9	480.5	23.4	19.2	124.3
New LSD at (0.05) =		1.8	1.4	1374.7	3.7	N.S.	77.8	N.S.	N.S.	9.1
		Second season								
Superior	Spanish Baron	26.1	8.7	10450.1	36.0	12.0	725.7	22.3	18.2	125.0
	Gable	13.0	8.6	10375.7	21.0	14.0	617.6	22.2	17.9	111.3
	Y-shape	9.0	6.0	7192.9	19.8	13.2	454.1	21.8	17.4	105.7
	T-shape	7.4	4.9	5927.4	18.2	12.1	407.1	21.5	17.2	96.3
New LSD at (0.05) =		1.9	1.3	1549.3	5.2	N.S.	111.3	N.S.	N.S.	16.9
Flame seedless	Spanish Baron	30.3	10.1	12139.1	45.1	15.0	672.9	21.5	16.8	195.3
	Gable	16.8	11.2	13454.3	28.5	19.0	590.1	21.0	16.4	179.3
	Y-shape	11.0	7.3	8795.6	23.2	15.5	473.9	19.7	16.1	149.1
	T-shape	9.6	6.4	7666.0	21.5	14.3	445.7	19.3	16.0	143.2
New LSD at (0.05) =		1.7	1.2	1247.2	4.9	N.S.	84.7	N.S.	N.S.	21.9
Thompson seedless	Spanish Baron	28.0	9.3	11206.8	39.6	13.2	707.5	23.8	19.1	171.2
	Gable	14.4	9.6	11518.3	23.2	15.5	620.6	23.4	18.9	164.0
	Y-shape	9.9	6.6	7881.3	21.1	14.1	466.9	23.1	18.6	127.0
	T-shape	7.8	5.2	6275.1	20.3	13.5	386.4	22.9	18.6	106.6
New LSD at (0.05) =		1.4	1.5	1486.4	4.2	N.S.	89.1	N.S.	N.S.	13.7

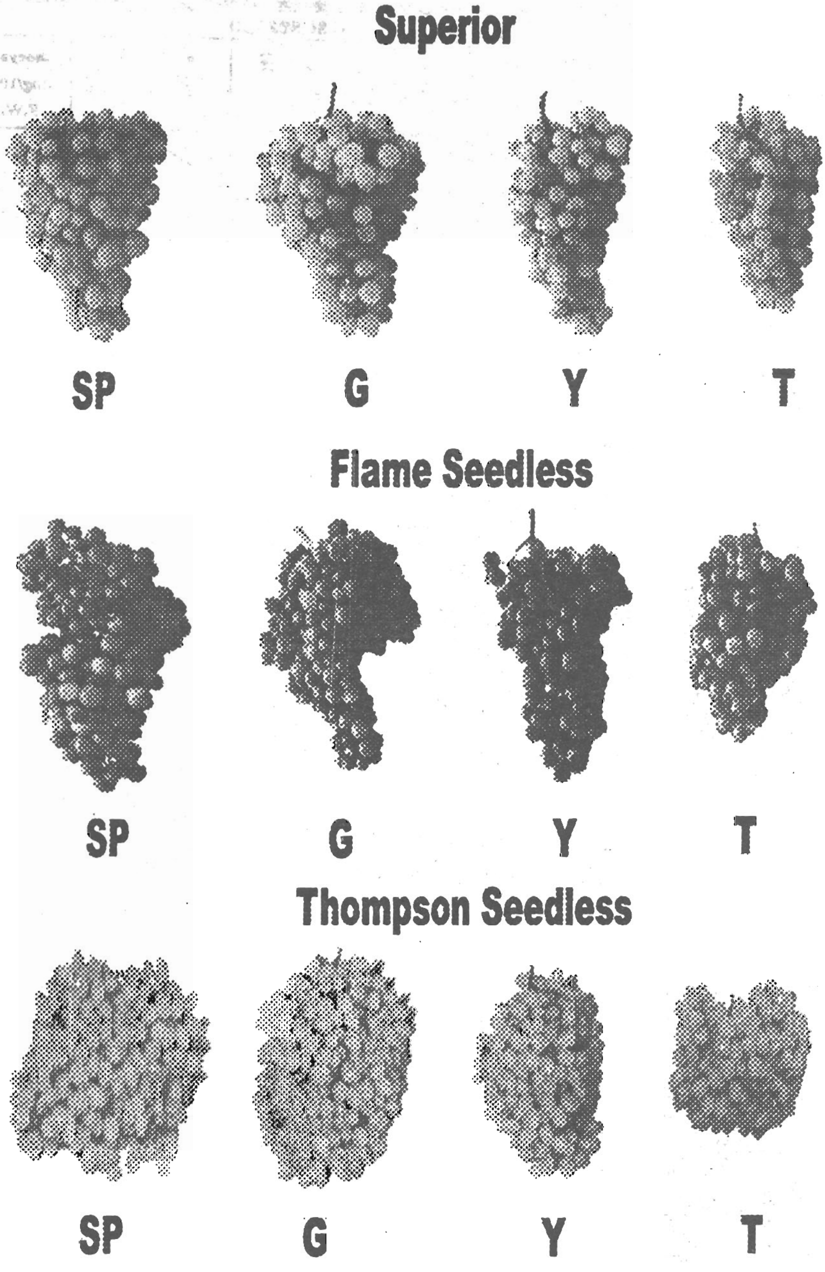


Fig.(3): Impact of trellis system on cluster quality of Superior, Flame Seedless and Thompson Seedless grape cultivars

Table (3): Impact of trellis system on berry physical and chemical characteristics of Superior, Flame Seedless and Thompson Seedless grapevines.

Variety	Trellis system	Berry weight (g)	Berry size (cm3)	Berry length (cm)	Berry diameter (cm)	TSS (%)	Acidity (%)	TSS/ acid ratio	Anthocya-nin (mg/100g F.W.)
		First season							
Superior	Spanish Baron	5.93	5.62	2.43	2.13	15.3	0.68	22.50	-
	Gable	5.68	5.39	2.33	2.04	15.7	0.65	24.15	-
	Y-shape	5.53	5.25	2.27	2.00	15.2	0.68	22.36	-
	T-shape	5.47	5.19	2.24	2.00	15.0	0.69	21.80	-
New LSD at (0.05) =		0.27	0.25	0.11	0.10	0.2	N.S.	1.47	-
Flame seedless	Spanish Baron	3.52	3.25	1.83	1.81	16.4	0.56	29.29	37.1
	Gable	3.38	3.12	1.76	1.74	16.9	0.52	32.50	35.8
	Y-shape	3.27	3.01	1.70	1.68	16.4	0.57	28.68	32.1
	T-shape	3.21	2.96	1.67	1.67	16.3	0.57	28.60	29.7
New LSD at (0.05) =		0.19	0.16	0.10	0.08	0.4	N.S.	1.83	3.5
Thompson seedless	Spanish Baron	4.23	3.99	2.07	1.78	15.5	0.50	31.00	-
	Gable	3.90	3.68	1.91	1.64	15.9	0.49	32.45	-
	Y-shape	3.78	3.57	1.85	1.59	15.4	0.51	30.20	-
	T-shape	3.71	3.50	1.82	1.57	15.2	0.51	29.80	-
New LSD at (0.05) =		0.35	0.34	0.17	0.16	0.3	N.S.		1.26
		Second season							
Superior	Spanish Baron	5.66	5.33	2.32	2.04	15.1	0.70	21.57	-
	Gable	5.39	5.08	2.21	1.94	15.4	0.66	23.34	-
	Y-shape	5.23	4.94	2.14	1.91	15.1	0.71	21.27	-
	T-shape	5.16	4.88	2.12	1.88	15.0	0.71	21.13	-
New LSD at (0.05) =		0.29	0.26	0.12	0.11	0.2	N.S.	1.31	
Flame seedless	Spanish Baron	3.36	3.07	1.75	1.73	16.2	0.58	27.93	33.4
	Gable	3.20	2.92	1.66	1.65	16.6	0.55	30.18	31.7
	Y-shape	3.07	2.80	1.60	1.60	16.1	0.58	27.76	26.9
	T-shape	3.00	2.75	1.56	1.56	16.1	0.59	27.29	25.1
New LSD at (0.05) =		0.18	0.17	0.11	0.09	0.3	N.S.	1.74	2.9
Thompson seedless	Spanish Baron	4.02	3.75	1.97	1.69	15.3	0.55	27.82	-
	Gable	3.67	3.41	1.80	1.55	15.7	0.52	30.19	-
	Y-shape	3.53	3.29	1.73	1.49	15.3	0.55	27.82	-
	T-shape	3.45	3.22	1.69	1.47	15.2	0.55	27.64	-
New LSD at (0.05) =		0.38	0.35	0.19	0.15	0.3	N.S.	1.92	-

Table (4): Impact of trellis system on the vegetative growth parameters, coefficient of bud fertility and total carbohydrates of Superior, Flame Seedless and Thompson Seedless grapevines

Variety	Trellis system	Shoot diameter (cm)	Shoot length (cm)	No. of Leaves per shoot	Coefficient of wood ripening	Weight of prunings (kg)		Yield/ Weight of prunings meter row	Trunk volume (cm3)		Coefficient of bud fertility	Total carbohydrates (%)
						vine	meter row		vine	meter row		
First season												
Superior	Spanish Baron	1.32	296.9	31.5	0.97	12.83	4.28	0.67	12244.8	4081.60	0.68	28.7
	Gable	1.26	266.5	28.3	0.94	9.91	6.61	0.78	6649.3	4432.87	0.66	25.8
	Y-shape	1.08	220.4	23.4	0.86	6.11	4.07	1.14	4236.2	2824.13	0.60	21.3
	T-shape	1.03	204.9	21.7	0.84	4.78	3.19	1.49	2892.7	1928.47	0.55	19.8
New LSD at (0.05) =		**0.07**	**37.9**	**5.3**	**0.04**	**2.03**	**2.67**	**0.56**	**971.6**	**523.7**	**0.03**	**3.7**
Flame seedless	Spanish Baron	1.23	285.6	29.7	0.94	11.75	3.92	0.86	10347.4	3449.13	0.91	27.6
	Gable	1.19	253.5	26.3	0.90	7.63	5.09	1.18	6022.3	4014.87	0.87	24.5
	Y-shape	1.08	208.2	21.6	0.82	4.16	2.77	2.29	3455.2	2303.47	0.79	20.1
	T-shape	1.06	191.6	19.9	0.79	3.22	2.15	2.51	2539.8	1693.20	0.73	18.5
New LSD at (0.05) =		**0.08**	**40.6**	**5.9**	**0.05**	**2.27**	**1.86**	**0.59**	**853.2**	**579.1**	**0.05**	**3.9**
Thompson seedless	Spanish Baron	1.29	263.8	32.5	0.92	10.66	3.55	0.99	9124.5	3041.50	0.66	25.5
	Gable	1.21	234.1	28.8	0.87	5.89	3.93	1.56	5769.5	3846.33	0.63	22.6
	Y-shape	1.07	186.6	23.0	0.79	3.27	2.18	2.23	3308.2	2205.47	0.55	18.0
	T-shape	1.05	168.9	20.8	0.76	2.42	1.61	3.11	2469.4	1646.27	0.53	16.3
New LSD At (0.05) =		**0.09**	**42.5**	**6.1**	**0.07**	**1.91**	**1.40**	**1.00**	**821.4**	**854.9**	**0.04**	**4.1**
Second season												
Superior	Spanish Baron	1.35	331.1	34.8	0.94	13.08	4.36	2.00	12612.1	4204.05	0.69	32.0
	Gable	1.29	297.6	31.2	0.91	10.13	6.75	1.28	6848.8	4565.85	0.71	28.8
	Y-shape	1.12	246.9	25.9	0.86	6.24	4.16	1.44	4363.3	2908.86	0.64	23.9
	T-shape	1.07	229.9	24.1	0.84	4.88	3.25	1.52	2979.5	1986.32	0.58	22.2
New LSD At (0.05) =		**0.06**	**46.3**	**6.8**	**0.04**	**2.17**	**2.75**	**0.47**	**997.3**	**649.3**	**0.03**	**4.5**
Flame seedless	Spanish Baron	1.27	305.4	31.4	0.93	11.95	3.98	2.54	10657.8	3552.61	0.94	29.5
	Gable	1.22	271.5	27.9	0.88	7.79	5.19	2.16	6203.0	4135.31	0.90	26.3
	Y-shape	1.11	223.4	23.0	0.78	4.25	2.83	2.59	3558.9	2372.57	0.81	21.6
	T-shape	1.08	205.8	21.2	0.75	3.29	2.19	2.91	2616.0	1744.00	0.77	19.9
New LSD at (0.05) =		**0.07**	**44.6**	**6.5**	**0.07**	**2.33**	**1.91**	**0.63**	**879.5**	**601.8**	**0.05**	**4.3**
Thompson seedless	Spanish Baron	1.26	279.2	34.4	0.87	10.82	3.61	2.59	9398.2	3132.75	0.66	27.0
	Gable	1.22	248.1	30.6	0.84	5.99	3.99	2.40	5942.6	3961.72	0.64	24.0
	Y-shape	1.09	198.4	24.4	0.76	3.34	2.23	2.95	3407.4	2271.63	0.59	19.2
	T-shape	1.06	178.7	22.0	0.74	2.47	1.65	3.17	2543.5	1695.65	0.56	17.3
New LSD At (0.05) =		**0.09**	**45.9**	**6.1**	**0.05**	**1.97**	**1.44**	**1.04**	**837.9**	**946.1**	**0.03**	**4.4**

Similar results were obtained concerning coefficient of wood ripening, weight of prunings and size of old wood. These parameters were significantly increased in Spanish Parron and Gable trellis systems as compared to Y and T shape trellis systems. The above results indicated that the total biomass produced in Spanish Parron and Gable trellis systems provided the frame work for leaf canopy that maximized light interception. The amount of old wood retained on the grapevine can also affect the yield and fruit quality. This may be due to the increased photosynthetic capacity (Kliewer 1973). These results are in accordance with (Reynolds and Wardle 1994, Carbonneau, 1999 and Abd El-Ghany and Marwad 2001), who recorded that the size of old wood must be developed progressively depending on vigor in order to regulate the water flow and increase the reserves close to bunches.

Positive effects attributed to Spanish Parron and Gable trellis systems were also evident as regards coefficient of bud fertility as compared to Y and T shape trellis systems. No significant difference was found between Spanish Parron and Gable trellis systems. The possible interpretation for the increase observed in coefficient of bud fertility for Spanish Parron and Gable trellis systems as compared to Y and T shape trellis systems lies in the fact that light interception by the foliage was increased and canopy density was reduced. However, low light levels occurring particularly during the period of bud induction and differentiation may result in low bud fruitfulness. These results agree with those found by (Orth and Chambers 1994, Smart, 1985 and Abd El-Ghany and Marwad 2001), who found that trellis widening caused an obvious increase in bud fertility in some grape cultivars.

Total carbohydrates of the canes% increased significantly with Spanish Parron and Gable trellis systems which had the highest light interception canopy compared to Y shape and T shape trellis systems which had the lowest light interception canopy in both seasons for the three cultivars. These results may be attributed to increased photosynthetic capacity (Kliewer 1973 and Abd El-Ghany and Marwad 2001), who mentioned that increased total carbohydrates is one of the important factors which affect bud fruitfulness through affecting C/N ratio.

With respect to, leaf area density, trellis system is an important factor that influences the physiological and management aspects of the grapevines. A great number of trellis systems have been utilized in order to better match trellis configuration to anticipated vine vigor. The values for various expressions of leaf area density for the four trellises systems are shown in Table (5). Data showed significant differences between trellis systems in leaf area either per vine or per meter row. Spanish Parron and Gable trellis systems significantly had the highest values of leaf area as compared to T shape trellis system which had the lowest values in both seasons for the three cultivars.

With regard to the leaf area index (LAI), it was determined by dividing leaf area per vine (m^2) by the total ground area (m^2) allotted to each vine. Results show that Spanish Parron and Gable trellis systems significantly increased leaf area index as compared to Y shape and T shape trellis systems in both seasons for the three cultivars. The increase in leaf area index in Spanish Parron and Gable trellis systems may be due to the increase in leaf area per vine attributed to the increase of width of trellis and light intercept on which were reflected on the increase in photosynthetic activity and vegetative growth specially leaf area of the plant.

Table (5): Impact of trellis system on the leaf area density of Superior, Flame seedless and Thompson seedless grapevines.

Variety	Trellis system	Leaf area (m^2) per vine	Leaf area (m^2) per meter row	LAI per vine	LA/Ca per vine	LA/Ca per meter row	LA/SA per vine	LA/SA per meter row
First season								
Superior	Spanish Baron	63.7	21.2	6.07	6.24	2.08	6.18	2.06
	Gable	29.1	19.4	5.53	5.70	3.80	2.91	1.94
	Y-shape	22.6	15.1	4.30	8.85	5.90	4.09	2.73
	T-shape	17.8	11.9	3.39	11.85	7.90	4.20	2.80
New LSD at (0.05) =		6.1	3.3	1.13	3.11	2.07	0.74	0.63
Flame seedless	Spanish Baron	61.2	20.4	5.83	5.83	1.94	5.98	1.99
	Gable	27.8	18.6	5.30	5.37	3.58	2.81	1.87
	Y-shape	22.9	15.3	4.36	8.98	5.99	4.13	2.75
	T-shape	18.0	12.1	3.43	11.99	7.99	4.28	2.85
New LSD at (0.05) =		4.8	3.2	0.93	3.34	2.23	0.86	0.71
Thompson seedless	Spanish Baron	67.7	22.6	6.45	6.64	2.21	6.69	2.23
	Gable	32.2	21.5	6.14	6.41	4.27	3.28	2.19
	Y-shape	23.4	15.6	4.46	9.41	6.27	4.10	2.73
	T-shape	17.2	11.5	3.28	11.48	7.65	4.42	2.94
New LSD at (0.05) =		7.1	5.3	1.34	2.43	1.61	0.56	0.49
Second season								
Superior	Spanish Baron	65.7	21.9	6.25	6.31	2.10	6.34	2.11
	Gable	30.8	20.5	5.86	5.98	3.98	3.10	2.07
	Y-shape	24.8	16.5	4.72	9.72	6.48	4.49	2.99
	T-shape	19.5	13.0	3.70	12.97	8.65	4.47	2.98
New LSD at (0.05) =		5.7	3.9	1.07	3.47	2.38	1.35	0.74
Flame seedless	Spanish Baron	62.8	20.9	5.97	6.04	2.01	5.98	1.99
	Gable	30.0	20.0	5.71	5.78	3.85	3.04	2.03
	Y-shape	24.9	16.6	4.74	9.76	6.51	4.48	2.99
	T-shape	19.5	13.0	3.72	13.02	8.68	4.65	3.10
New LSD at (0.05) =		4.9	3.3	0.91	3.76	2.41	1.29	0.93
Thompson seedless	Spanish Baron	67.9	22.6	6.46	6.71	2.24	6.79	2.26
	Gable	32.2	21.4	6.12	6.43	4.29	3.38	2.25
	Y-shape	24.3	16.2	4.63	9.52	6.35	4.38	2.92
	T-shape	17.6	11.8	3.36	11.76	7.84	4.41	2.94
New LSD at (0.05) =		7.6	4.8	1.41	2.89	1.75	0.82	0.59

The leaf area to canopy area ratio (LA/CA) was calculated by dividing leaf area per vine (m^2) by the ground area covered by the vine canopy (m^2). T shape trellis system had the highest values in this respect as compared to Gable and Spanish Parron trellis systems which had the lowest values which was due to the large canopy. These results were clearer in meter row. The width of canopy for trellis systems Gable and Spanish Parron was more than 3.5 m while, the Y shape trellis system was around 1.70m and T shape trellis system was around 1.0m. The width of trellis system influences canopy framework which plays an important role in photosynthetic activity by increased light interception.

LA/SA was determined by dividing leaf area per vine (m^2) by the canopy surface area per vine (m^2). It is obvious that leaf area to canopy surface ratio in meter row in Y shape and T shape trellis systems was higher compared to Spanish Parron and Gable trellis systems which had the lowest values. This may be due to dividing leaf area by the canopy surface area.

From the above results it is clear that canopy surface area was increased in the two systems Spanish Parron and Gable as compared to Y shape and T shape trellis systems. These results are in agreement with those finding of Ezzahouani and Williams (2003) on Ruby Seedless grapevines, they pointed out that triple T design had greater shoot growth, leaf area and pruning weights than the double tee design.

4- Microclimate data:

Data concerning average air temperature, crop temperature, humidity percentage and sunlight intensity are presented in table (6). The results showed that air temperature for the lower systems (T-shape and Y-shape) was higher than that for the other systems; (Gable and Spanish Parron) for all studied cultivars in both seasons. The influence of air temperature may be ascribed to its vital role in gas exchange, Co_2 uptake and photosynthesis activity. These results are in accordance with Ferrini *et al.* (1995) who found that temperature acts mainly on net photosynthesis and plant growth. Significant too was temperature's influence on chlorophyll content which was directly linked to average photosynthesis trend. With regard to crop temperature, it can be shown that Spanish Parron and Gable systems recorded the lowest values as compared with T-shape and Y-shape systems. These results agree with Reynolds *et al* (1995) who stated that temperature of Geneva Double Curtain (GDC) clusters was lower than that of Hudson River Umbrella (HRU). In general, the average crop temperature was found to be higher than average air temperature. These results are in agreement with Ezzahouani & Williams (2003). Relative humidity percentage differed depending upon the trellis system; it was increased in the lower trellis systems. Spanish Parron and Gable systems recorded the lowest values in the three cultivars, while T-shape and Y-shape systems resulted in the highest values in this respect. The increase of humidity percentage may be ascribed to the high transpiration rate which was increased in low trellis systems.

These results are in accordance with Zhang & Carbonneau (1987) observed a lower stomata conductance with an increase in the trunk height. Also, Baeza *et al.* (2000) who recorded a higher transpiration rate in those systems with low surface area.

Table (6): Impact of trellis system on the microclimate data of Superior, Flame Seedless and Thompson Seedless grapevines.

Variety	Trellis system	Air temperature (Co)	Crop temperature (Co)	Relative humidity (%)	Sunlight intensity (Watt)
		First season			
Superior	Spanish Baron	27.5	31.3	24.2	70.6
	Gable	27.8	30.8	23.8	74.4
	Y-shape	28.0	32.1	33.3	64.0
	T-shape	27.9	33.5	35.3	62.6
New LSD at (0.05) =		0.2	2.1	10.6	4.6
Flame seedless	Spanish Baron	27.2	30.1	24.0	70.8
	Gable	27.0	30.0	23.1	75.2
	Y-shape	27.5	32.8	32.0	67.6
	T-shape	27.7	34.5	33.5	60.9
New LSD at (0.05) =		0.5	4.3	9.1	5.4
Thompson seedless	Spanish Baron	27.3	29.1	30.7	67.2
	Gable	27.0	28.7	29.7	71.7
	Y-shape	27.5	32.8	34.2	64.0
	T-shape	28.3	34.3	35.5	53.7
New LSD at (0.05) =		0.9	5.1	4.7	5.5
	Second season				
Superior	Spanish Baron	26.3	30.4	24.7	75.7
	Gable	27.0	30.0	25.5	76.1
	Y-shape	27.8	32.2	34.0	70.7
	T-shape	28.0	34.4	36.0	66.9
New LSD at (0.05) =		0.8	3.8	10.1	3.7
Flame seedless	Spanish Baron	27.5	29.5	23.9	74.8
	Gable	27.8	29.8	22.1	72.8
	Y-shape	27.9	33.4	33.7	61.2
	T-shape	28.0	34.8	35.1	52.7
New LSD at (0.05) =		0.2	4.7	10.9	5.1
Thompson seedless	Spanish Baron	27.5	30.1	29.1	66.9
	Gable	27.1	30.0	31.7	68.0
	Y-shape	28.0	33.4	34.0	64.6
	T-shape	28.2	35.2	34.7	51.3
New LSD at (0.05) =		0.7	4.5	2.9	2.6

Sunlight intensity was found to increase by the increase in the height and width of trellis in Spanish Parron and Gable systems with more length dividing canopy surface area. The increase of leaf area in the two trellis systems may have resulted in much more light being intercepted by canopy when compared with the other two trellis systems; T-shape and Y-shape, resulting in a higher production of photosynthates. These results are in line with Baeza *et al.* (2000) who found that the net photosynthesis was higher in vertical trellis which had a higher canopy surface area (SA). The photosynthesis is the key element of the plant physiology (Stoev & Slavtchava 1982). Guardiola & Garcia 1990 stated that the physiological activity can be an important factor for yield, growth and fruit quality.

5- Coefficient of bud fertility:

Determination of bud fertility coefficient at each bud position lengthwise the cane is necessary for determining the suitable length of the cane in the pruning process and hence for the choice of the appropriate trellising system for each cultivar.

Concerning the coefficient of bud fertility lengthwise the cane in Superior and Thompson Seedless grapevines, the results illustrated in Fig. (4) show that this estimate increased gradually from the basal buds to the middle buds of the cane then decreased gradually towards the distal buds. However, the basal sector (1st to 3rd bud) of canes had the lowest values of fertility coefficient as compared to the subsequent sectors. A remarkable increase occurred on the second sector (form the 4th to the 6th bud), then a slight increase was observed at the subsequent sectors. The differences between all trellis systems were clear in both seasons؛ it is evident that Spanish Parron and Gable systems had the highest values of bud fertility coefficient lengthwise the cane in both seasons. T-shape and Y-shape systems had the lowest values in both seasons.

With respect to the coefficient of bud fertility lengthwise the cane of Flame Seedless grapevines, the results shown in Fig. (4) indicated that coefficient of bud fertility increased gradually from the basal buds to the distal buds (the fifth bud). The differences between all trellis systems were clear in both seasons؛ it is evident that Spanish Parron and Gable systems had the highest values of coefficient of bud fertility lengthwise the cane in both seasons, while, T-shape and Y-shape systems had the lowest values in both seasons.

In this respect, Monastra (1971), Sourial (1976), Fawzi *et al.* (1984), Abd El-Kawi and El-Yami (1992) and Aisha *et al.* (1998) found that the fruitfulness of buds increased from the basal to the distal buds of the canes.

Data illustrated in Figure (5 & 6 & 7) indicated the presence of a positive correlation between the weight of prunings (kg) (m/row) and yield (kg) (m/row), between the trunk volume (cm^3) (m/row) and yield (kg) (m/row) and between the leaf area (m^2) (m/row) and yield (kg) (m/row) in both seasons for the three cultivars.

- **Economical justification of different trellis systems compared with T-shape trellis (The lowest trellis in productivity):**

It can be shown from the data presented in (Table 7) that Spanish Parron and Gable trellis systems (as the best treatments) gave the maximum net profit compared with the T-shape trellis (The lowest trellis in productivity) in both seasons for the three cultivars. The moderate rise in the cost of production/feddan in these trellis systems are economically justified in view of the higher price of bunches in these systems.

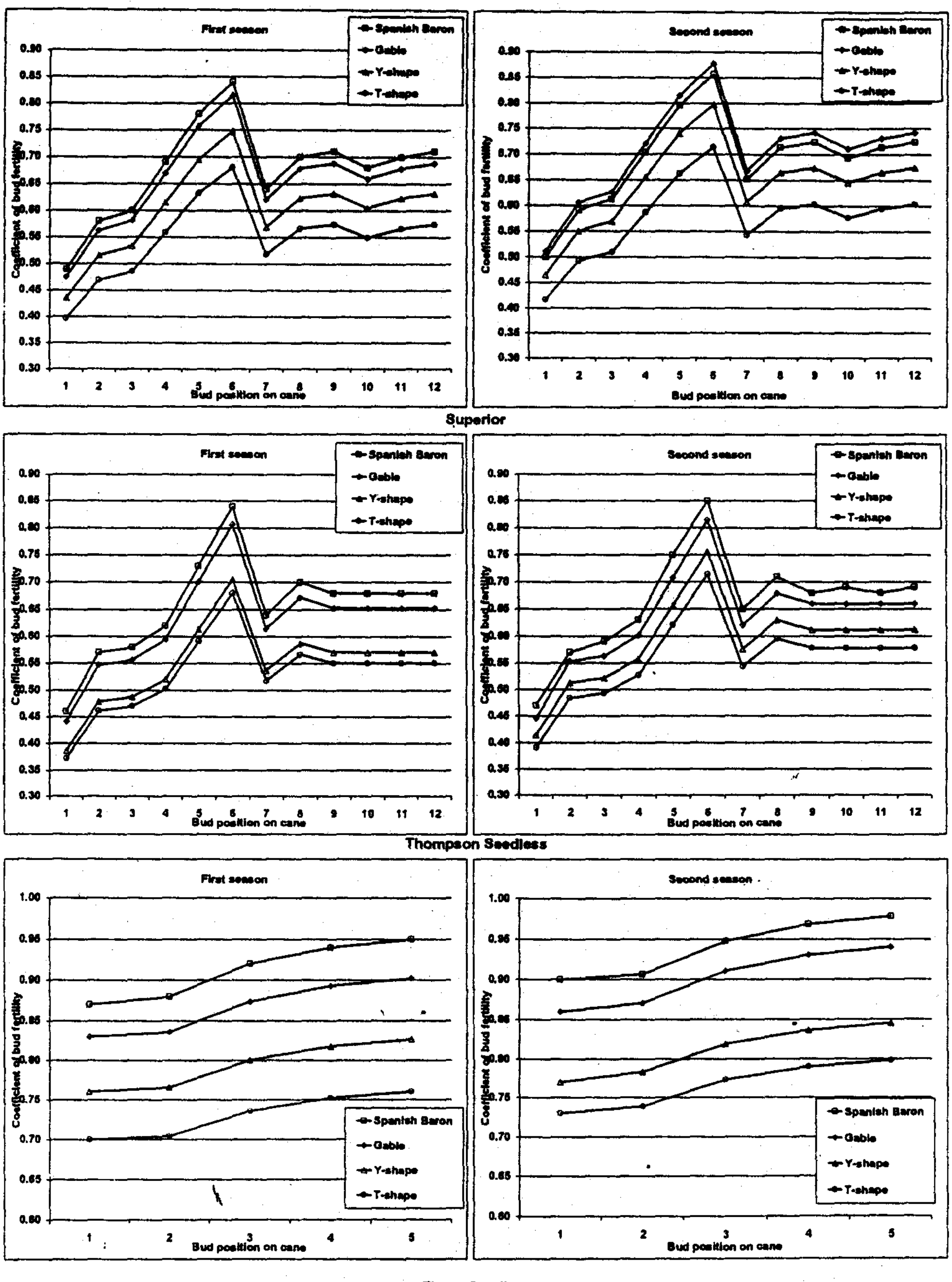
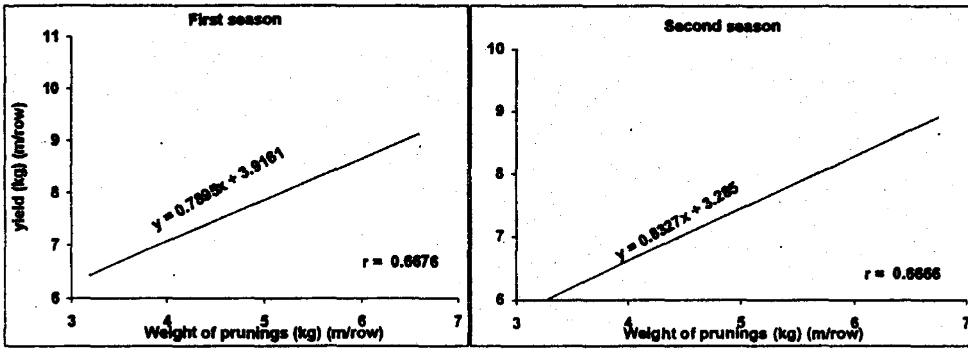
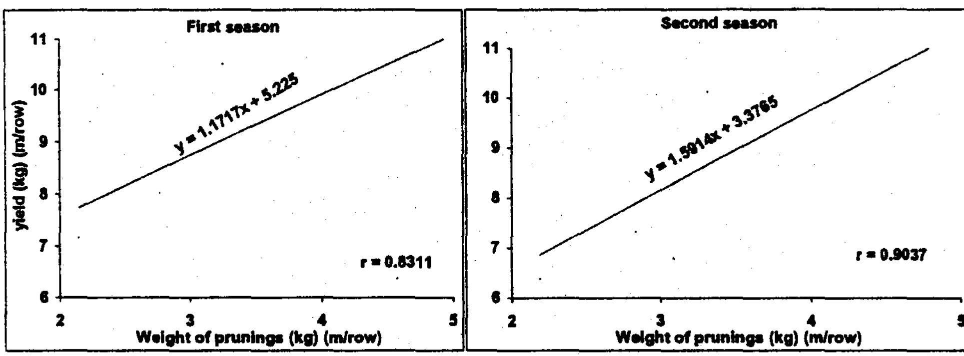


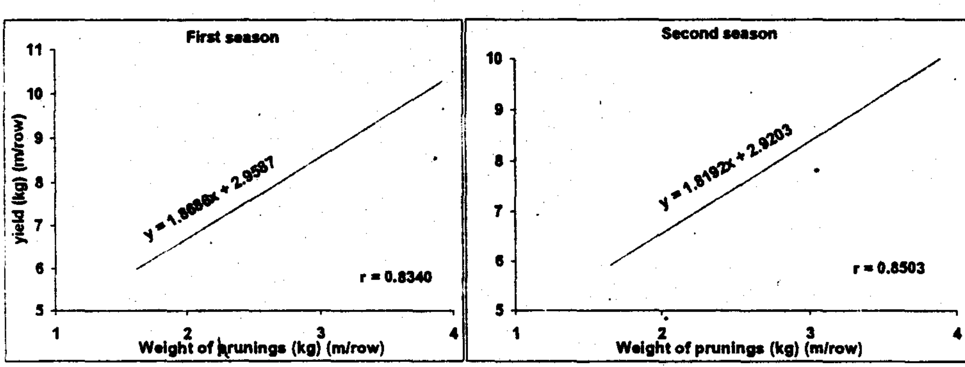
Fig (4):Coefficient of bud fertility as affected by different trellis systems for three cultivars in both seasons



Superior

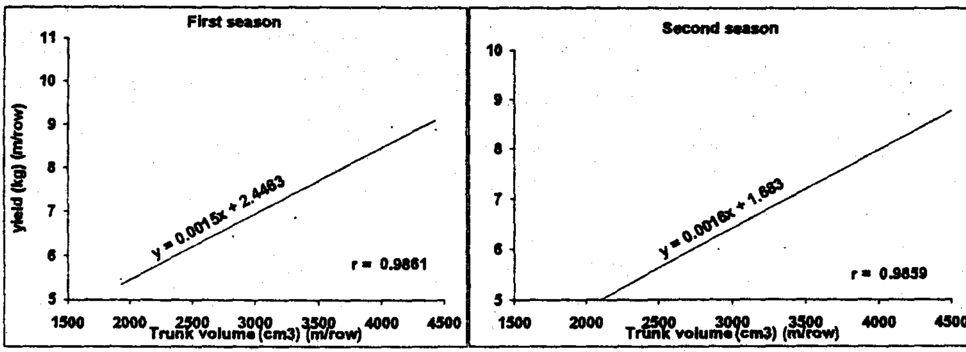


Flame seedless

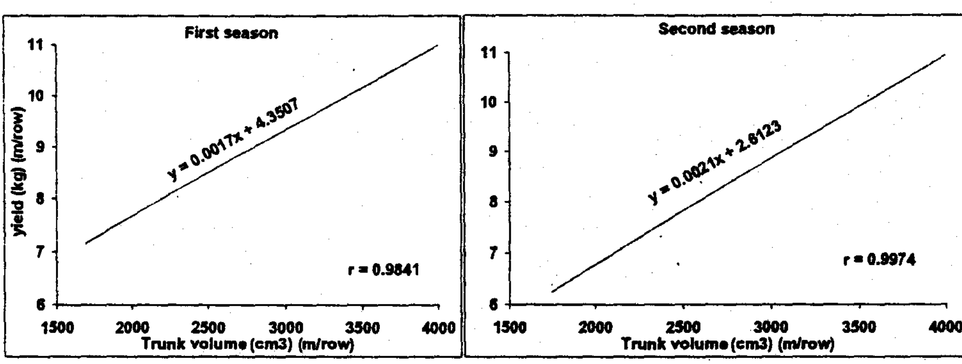


Thompson seedless

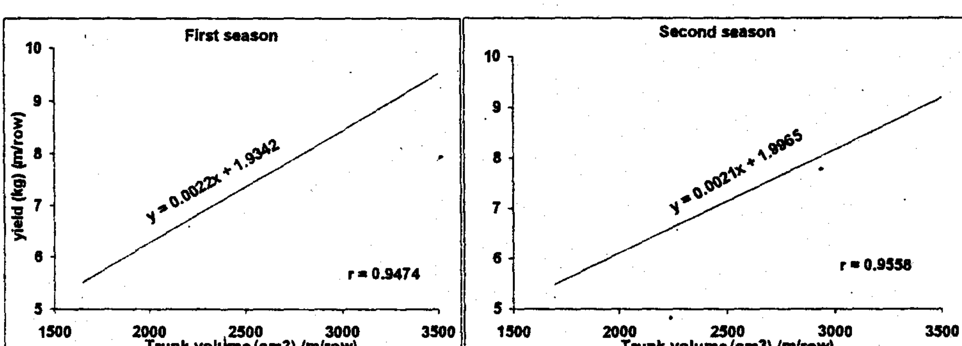
Fig (5): The relationship between the weight of prunings (kg) (m/row) and yield (kg) (m/row) in both seasons



Superior



Flame seedless



Thompson seedless

Fig (6): The relationship between the trunk volume (cm^3) (m/row) and yield (kg) (m/row) in both seasons

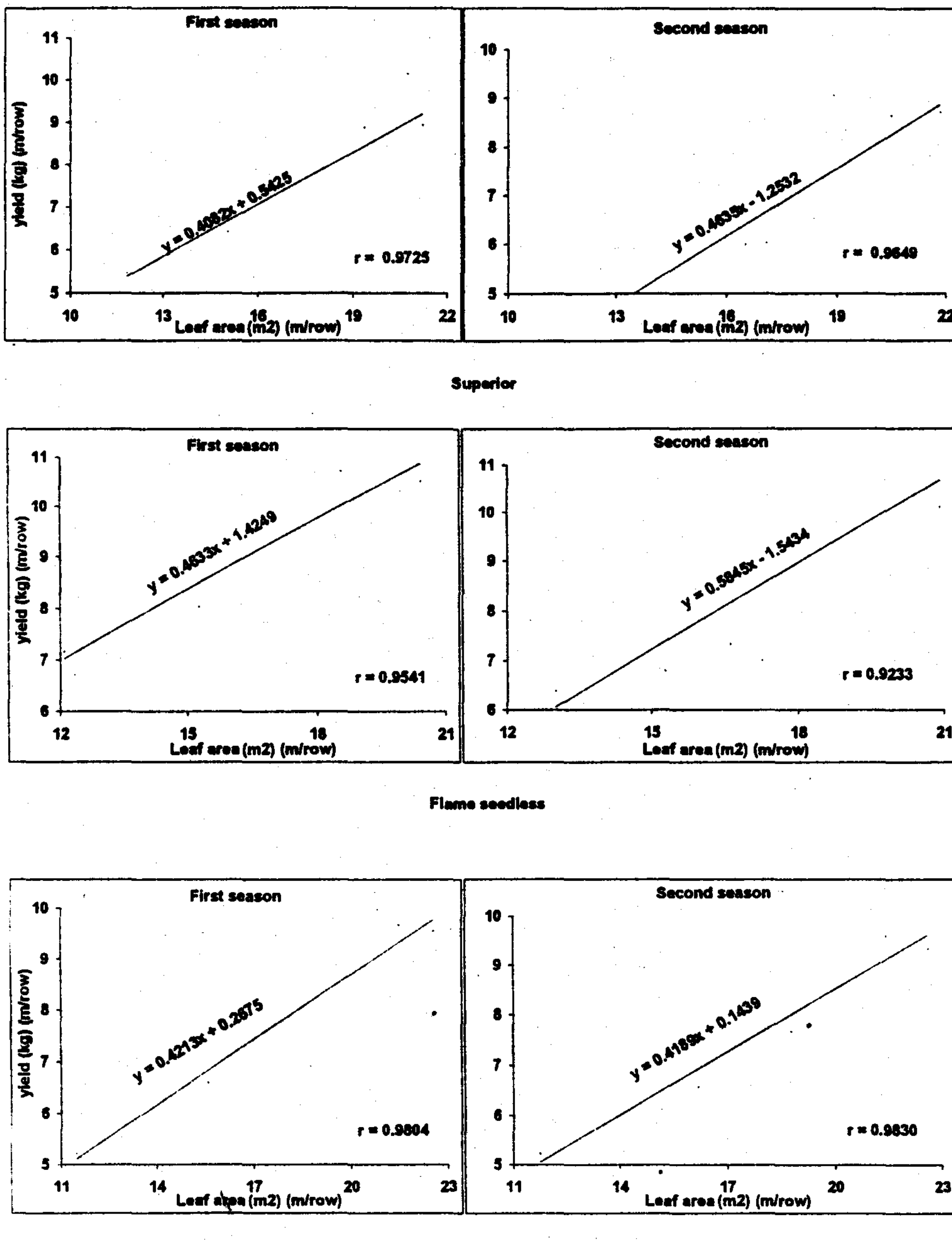


Fig (7): The relationship between the leaf area (m^2) (m/row) and yield (kg) (m/row) in both seasons

Table (7): Economical justification of different trellis systems compared with T-shape trellis (The lowest trellis in productivity)

Per Feddan	Superior				Flame Seedless				Thompson Seedless			
	First season											
	Spanish Baron	Gable	Y-shape	T-shape	Spanish Baron	Gable	Y-shape	T-shape	Spanish Baron	Gable	Y-shape	T-shape
Cost of cultural practices (L.E.)	3000	2800	2650	2500	3500	3250	3000	2900	3400	3150	2950	2850
Price of the increase in Cost of cultural practices over T-shape trellis (L.E.)	500	300	150	---	600	350	100	---	550	300	100	---
Yield in (Kg)	10730.8	10667.2	7723.3	6549.4	12621.4	12866.3	9639.0	8592.4	11453.4	11597.0	7921.4	6265.7
Increase of the yield over T-shape trellis (Kg)	4181.4	4117.8	1173.9	---	4029.0	4273.9	1046.6	---	5187.7	5331.3	1655.7	---
Kg (L.E.)	1.90	1.90	1.70	1.65	1.85	1.85	1.65	1.60	1.80	1.75	1.55	1.50
Price of the increase in Kg over T-shape trellis (L.E.)	0.25	0.25	0.05	---	0.25	0.25	0.05	---	0.30	0.25	0.05	---
Yield (L.E.)	20388.5	20267.7	13129.6	10806.4	23349.6	23802.7	15904.4	13747.9	20616.1	20294.8	12278.2	9398.6
Price of the increase in yield over T-shape trellis (L.E.)	9582.0	9461.2	2323.2	---	9601.8	10054.9	2156.5	---	11217.5	10896.2	2879.7	---
The net profit (L.E.)	17388.5	17467.7	10479.6	8306.4	19849.6	20552.7	12904.4	10847.9	17216.1	17144.8	9328.2	6548.6
The net profit (L.E.) over T-shape trellis (L.E.)	9082.0	9161.2	2173.2	---	9001.8	9704.9	2056.5	---	10667.5	10596.2	2779.7	---
Per Feddan	Second season											
	Spanish Baron	Gable	Y-shape	T-shape	Spanish Baron	Gable	Y-shape	T-shape	Spanish Baron	Gable	Y-shape	T-shape
Cost of cultural practices (L.E.)	2700	2500	2350	2200	3300	3200	2800	2700	3150	2950	2700	2600
Price of the increase in Cost of cultural practices over T-shape trellis (L.E.)	500	300	150	---	600	500	100	---	550	350	100	---
Yield in (Kg)	10450.1	10375.7	7192.9	5927.4	12139.1	13454.3	8795.6	7666.0	11206.8	11518.3	7881.3	6275.1
Increase of the yield over T-shape trellis (Kg)	4522.7	4448.3	1265.6	---	4473.1	5788.2	1129.5	---	4931.7	5243.2	1606.1	---
Kg (L.E.)	2.00	1.95	1.80	1.75	1.95	1.85	1.70	1.65	1.85	1.85	1.60	1.55
Price of the increase in Kg over T-shape trellis (L.E.)	0.25	0.20	0.05	---	0.30	0.20	0.05	---	0.30	0.30	0.05	---
Yield (L.E.)	20900.2	20232.6	12947.3	10372.9	23671.3	24890.4	14952.5	12649.0	20732.6	21308.9	12610.0	9726.5
Price of the increase in yield over T-shape trellis (L.E.)	10527.3	9859.7	2574.4	---	11022.3	12241.5	2303.5	---	11006.1	11582.5	2883.6	---
The net profit (L.E.)	18200.2	17732.6	10597.3	8172.9	20371.3	21690.4	12152.5	9949.0	17582.6	18358.9	9910.0	7126.5
The net profit (L.E.) over T-shape trellis (L.E.)	10027.3	9559.7	2424.4	---	10422.3	11741.5	2203.5	---	10456.1	11232.5	2783.6	---

In conclusion, it can be stated that Spanish Parron and Gable were the best trellis systems, since they achieved the best yield and its components as well as the best physical properties of bunches, improved the physical and chemical characteristics of berries and ensured the best vegetative growth parameters, coefficient of bud fertility and total carbohydrates of canes in comparison with the other systems. In addition they gave the best distribution of the vegetative growth which was reflected on high sunlight capture, considerably higher vine canopy and adequate bunch exposure for achieving better fruit quality.

REFERENCES

Abd El-Ghany, A.A. and Marwad, I.A. (2001): Effect of trellis system shape on Thompson Seedless grapevine productivity. J. Agric. Sci. Mansoura Univ., 26 (3): 1649 – 1654.

Abd El-Kawi, A. and El-Yami, S.A. (1992): Bud behaviour of four grape varieties in Tiaf Region. S.A.J. Agric. Sci. Mansoura. Univ. 17 (7): 2451-2456.

Aisha. S.A. Gaser, El-Mogy, M.M. and Omar, A.H. (1998): Coparative studies on description and evaluation of five new table grape cultivars under Egyptian conditions. Annals of Agric. Sci., Vol 36 (4) 2473-2486.

Association of Official Agricultural Chemists (1985): Official Methods of Analysis A. O. A. C., Benjamin Franklin Station, Washington, D. C. N. S. A. pp 440-510.

Beaza, P.; Ruiz, Carmen, M. and Lissarrague, J. (2000): Differences in gas exchange in Cv. Tempranllo (Vitis Vinera L.) As affected by training system. Acta Hort. 526: 391-396.

Bergqvist J. Dokoozlian, N. and Ebisuda, N. (2001): Sunlight exposure and temperature effects on berry growth and composition of Cabernet Sauvignon and Grenache in the central San Joaquin Valley of California. Amer. J. Enol. Vitic. 52:1-7.

Bouard, J. (1966): Recherches physiologiques sur la vigne et en particulier pour l'aoutment des sarments. Thesis Sc. Nat Bordeaux-France. Pp.34.

Carbonneau, A. (1999): Vineyard training systems: results of the French Mediterranean network. Progres. Agricole Viticole, 116 (22-23): 483-485;503-517 (C.F. Hort. Abst. 70:2938).

Crippen, D.D. and Morrison, J.C. (1986): The effects of sun exposure on the compositional development of Cabernet Sauvignon berries. Amer. J. Enol. Vitic. 37:235-242.

Dokoozlian N.; Ebisuda, N. and Thomas, J. (1998): Canopy management practices for gable trellis systems. Research Report of California Table Grapes, 23: 1-7.

Dokoozlian, N. K. and Kliewer, W.M. (1995): The light environment within grapevine canopies. I. Description and seasonal changes during fruit development. Amer. J. Enol. Vitic. (46): 209- 218.

Ende Van den, B. (1984): The Tatura trellis-A system of growing grapevines for early and high production. Amer.J.Enol. Viticult. 35:82-87.

Ezzahouani A. Williams L.E. (2003): Trellising, fruit thinning and defoliation have only small effects on the performance of Ruby Seedless grape in Morocco. J. Hort. Sci. & Biotechnology. 78(1):79-83.

Fawzi, F.; Bondok, A. Z. and Ghobrial G. F. (1984): Effect of cane length on bud behaviour and wood ripening of "Thompson Seedless" grape variety; Annals Agric., Ain-Shams Univ., Cairo, Egypt. 29 (1) 465-483.

Ferrini, F.; Mattii, G.B. and Nicese, F.P. (1995): Effect of temperature on key physiological responses of grapevine leaf. Am. J. Enol. Vitic., 46(3): 375-379.

Guardiola, J. L. and Garcia, A. (1990): Fisiologia vegetal I: nutricion Y transporte. Sintesis, Madrid, Spain.

Hassan, F. F.; Rizk, I. A.; Abd El-Kawi, A. and Ghobrial, G. F. (1991): Effect of old wood size on bud behaviour, yield and bunch characteristics of "Italia" grape variety. Egypt, J. Appl. Sci., 6(8):239-251.

Husia, C. L.; Luh, B. S. and Chichester, C. D. (1965): Anthocyanin in free stone peach. J. Food Science, 30: 5-12.

Kliewer, W. M. (1971): Effect of day temperature and light intensity on concentration of malic and tartaric acids in vitis vinifera L. grapes. J. Amer. Soci. Hort. Sci., (96): 372-379.

Kliewer, W. M. (1973): How does a grapevine make sugars. Dep. of Vitic. and Eno., Davis. Cooperative Extension. Univ. of California.

Kliewer, W.M.; Wolpert, J. A. and Benz, M. (2000): Trellis and vine spacing effects on growth, canopy microclimate, yield and fruit composition of Cabernet Sauvignon. Acta Hort. 526:21-31.

Kliewer, M. W.; Marois, J. J.; Bledsoe, A. M.; Smith, S.P.; Benz, M. J. and Silvestroni, 0. (1988): Relative effectiveness of leaf removal, shoot positioning, and trellising for improving wine grape composition. In: Proc. 2nd Int. Symp. Cool Climate Viticulture and Oenology. pp. 123-126. New Zealand Society for Viticulture and Oenology, Auckland.

Kliewer, W. M. and Weaver, R.J. (1971): Effect of crop level and leaf area on growth, composition and coloration of "Tokay" grapes. Amer. J. Enol. Vitic. (122): 172-178.

Koblet, W. and Perret, P. (1982): The role of old vine wood on yield and quality of grapes. In: Proc. Cent. Symp. for grapes and wines, UC Davis (A.D. Webb. Ed). Pp 164-169. University of California Press, Berkeley.

Konlechner, H. (1961): Standraum und Qualitat. Der Deutsche Weinbau 16:627-628.

Mabrouk, H., Carbonneau, A. and Sinoquet, H. (1997): Canopy structure and radial regime in grapevine. I. Spatial and angular distribution of leaf area in two canopy systems. Vitis 36(3): 119-123.

May, P., Clingeleffer, P.R. and Scholfield, P.B. (1976): The response of the grape cultivar Crouchen (Australia syn. Clare Riesling) to various trellis and pruning treatments. Austral. J. Agr. Res. 27:845-856.

Mihailov, A. (1980): Influence of training system trunk formation of grapevine and their pruning treatment on the manifestations of growth and yield of the variety Rkatziteli. Bulgarian. Gradinarska Y Lozar. Nauka 17(1): 82-89.

Monastra, F. (1971): Pruning intensity in curtain trained vines. Rivista di Viticultura e di. Enologta 24 (6): 221-235. (Hort. Abst., 24:847).

Ollat, N. and Carbonneau, A. (1992): Influence du systeme de confutes sur la regulation du regime hydrique et de la photosynthese. Quad. Vitic. Enol. Univ. Torino, 16:245-248.

Orth, C. H. F. and Chambers, K. R. (1994): Training-trellis system and canopy management of table grape in South Africa. Amer. Soc. Eno. and Viticulture. Vitis, 34(1): 189-190.

Prasad, A. and Pandev, S.D. (1969): Simple and quick mehtod of determining fruitfulness dormant buds in grape. The Indian J. Hort. 62 No. 3: 121-123.

Reynolds, A. G., and Wardle, D. A. (1994): Canopy manipulation of Okanagan Riesling vines for improvement of wine grape quality. Can .J. Plant Sci. 72:489-496.

Reynolds, A. G.; Wardle, D. A. and Naylor (1995): Impact of training system and vine spacing on vine performance and berry composition of Chancellor. Amer. J. Enol. Vitic. 46(1):88-97.

Shaulis, N.J. (1980): Responses of grapevines and grapes to spacing of and within canopies. In: Proceedings of the University of California, Davis, Grape and Wine Centennial Symposium. pp 353-361. University of California Press, Berkeley.

Shaulis, N.J., Amberg, H. and Crowe, D. (1966): Response of Concord grapes to light, exposure, and Geneva Double Curtain training. Proc. Am. Soc. Hortic. Sci. 89:268-280.

Smart, R. E. (1973): Sunlight interception by vineyards. Amer. J. Enol. Vitic. 24:141-147.

Smart, R. E. (1985): Principles of grapevine canopy microclimate manipulation with implications for yield quality; A review Amer. J. Enol. Viticult., 35:230-239.

Smart, R. E. (1988): Shoot spacing and canopy light microclimate. Amer. J. Enol. Vitic. 39:325-333.

Smart, R. E., Robnson, J. B., Due, G. and Brien, C. J. (1985): Canopy microclimate modification for the cultivar Shiraz. II. Effects on must and wine composition. Vitis 24:119-128.

Smart, A. E., Shaulis, N. J. and Lemon, E. R. (1982): The effect of Concord vineyard microclimate on yield. II. The interrelations between microclimate and yield expression. Am. J. Enol. Vitic. 33:109-116.

Smart, R. E., and Smith, S. M. (1988): Canopy management: identifying the problems and practical solutions. In: Proc; 2nd Int. Symp. Cool Climate Viticulture and Oenology. pp 109-115. New Zealand Society for Viticulture and Oenology, Auckland.

Smith, F., Gilles, M. A., Hamilton, J. K. and Gedess, P. A. (1956): Colorimetric methods for determination of sugar and related substances. Anal. Chem. 28: 350.

Snedecor, G.W. and Cocharn, W.G. (1990): Statistical Methods, 7th Ed. The Iowa State Univ. Press. Amer. Iowa. USA. P 593.

Sourial, G. F. (1976): Effect of pruning severity on "Thompson Seedless" vines. I Yield and fruit quality. II Bud burst and fertility. III Vegetative growth; Annals of Agricultural Science, Moshtohor. (5) 195-202, 203-210, 211-215.

Steinhauer, R.E. and Bowers, K.W. (1979): Influence of trellis on yield and quality of Cabernet Sauvignon in Nape Valley. Amer. J. Enol. Vitic. 30:236-240.

Stoev, K. and Dobreva, S. (1976): Influence du mode de conduite de la vigne sur la photosynthese et la distribution des substances elaborees. Connaissance Vigne Vin 10: 125-139.

Stoev, K.D. and Slavtcheva, T. (1982): La photosynthese nette chez la vigne (Vitis vinifera L.) et les facteurs ecologiques. Connaiss, Vigne Vin 16: 171-185.

Tourky, M.N. El-Shahat, S.S. and Rizk, M.H. (1995): Evaluation of some new grape cultivars in redation to growth yield, berry quality and storage life. J Agric. Sci. Manasoura Univ. 29 (12):153-5167.

Weaver, R.J. and Kasimates, A. N. (1975): Effect of high trellis with and without cross arms on yield of Thompson Seedless grapes. J. Amer. Soc., 100 (3): 252-253.

Zhang, D.P. and Carbonneau, A. (1987): Etude du trajet de la seve brute en function de la longueur du tronc chez la vigne. Congress de Fisiologia. O1V. 190-196.

سلوك بعض أصناف العنب تحت نظم تدعيم مختلفة

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أجرى هذا البحث لدراسة تأثير بعض نظم التدعيم علـى المحصـول ومكوناتـه والصفات الطبيعية والكيماوية للحبات والنمو الخضرى ومعامـل نضـج الخشـب ووزن القصاصة وحجم الجذع ومحتوى القصبات من الكربوهيـدرات بالاضـافة إلـى معامـل الخصوبة على ثلاثة أصناف من العنب وهى: السوبيريور، الفلـيم سـيدلس، الطومسـون سيدلس لتقييمها تحت أربعة نظم تدعيم وهى تكاعيب شيلى، تكاعيب جيبل ، نظام التـدعيم شكل Y، نظام التدعيم T المزدوج. وكانت الكرمات عمرها ثمانية سنوات مزروعـة فـى تربة رملية تروى بنظام الرى بالتنقيط، منزرعة على مسافات ٣,٥x١,٥ متر بالنسبة لـنظم تكاعيب جيبل ، نظام التدعيم شكل Y ، نظام التدعيم T المزدوج بينما نظام تكاعيب شـيلى كانت منزرعة على مسافات ٣,٥ x٣ متر. وكانت كرمات عنب السوبيريور والطومسـون سيدلس قد تم تقليمها بالتقليم القصبى مع ترك ٦٠ عين/متر من خط الزراعة بينما كرمـات عنب الفليم سيدلس تم تقليمها بالتقليم الكردونى مع ترك ٤٠ عين/متر من خط الزراعة.

وقد أشارت نتائج الدراسة إلى أن نظامى التدعيم تكاعيب شيلى، تكاعيـب جيبـل كانت أفضل نظم التدعيم حيث أعطت أعلى محصول ومكوناته بالاضـافة إلـى تحسـين الصفات الطبيعية والكيماوية للحبات مع الحصول على أفضل قياسات خضرية وديناميكيـة نضج الخشب ومعامل خصوبة البراعم ومحتوى القصبات مـن الكربوهيـدرات مقارنـة بنظامى التدعيم الآخرين.