Promoting Irrigation Water Utilization Efficiency in Superior Vineyards

A.S. El- Khawaga[1] and A.M.A. EL-Naggar[2]

[1]Hort. Dept. Qena Fac. of Agric., South Valley University, Egypt

[2]Soil and Water Dep., Fac. of Agric., Cairo University, Egypt

Abstract—The different laterals and emitters frequency on growth, leaf content of N, P, K, Mg, S, Zn, Fe and Mn, berry setting %, yield as well as physical and chemical characteristics of superior grapes were investigated during 2009 and 2010 seasons. Eight years old superior grape vines grown at 1.75 X 2.75 m apart in sandy loam soil in Qena Governorate under drip irrigation system with 4L\h emitters were used in this study. One or two laterals and two to six emitters per vine were used. Results revealed that leaf area, main shoot length, leaf content of N, P, K, Mn, S, Zn, Fe and Mn, berry setting %, yield, cluster weight as well as physical and chemical characteristics of the grapes markedly improved with increasing number of laterals from one to two and number of emitters from two to six. Increasing emitters' frequency from four to six on double laterals gave significant effect on the above mentioned characters. The best recommended treatment for increasing irrigation water utilization efficiency in Superior vineyards as well as improving yield quantitatively and qualitatively is double laterals and six emitters/ vine.

Keywords— efficiency, emitters, promoting, Superior vineyards.

I. INTRODUCTION

Water management is a critical aspect of successful grape production in Egypt [1] and [2]. In new vineyards of reclaimed areas in Egypt and especially where irrigation water is scarce, trickle irrigation is increasingly being introduced. Water applied via trickle irrigation at the proper time and quantity can influence grape yields and fruit quality[3]. In addition, water can be a scarce resource in many areas and its efficient use must be a high priority, [4] Thus, methods for scheduling irrigation are an important aspect of good vineyard management [5]. One of the main advantages of drip irrigation is the opportunity to obtain high system uniformity. In general, drip irrigation systems often achieve over 90 % uniformity with proper design, installation and maintenance. This is in contrast to typica1 uniformities of 40 – 60 for gravity systems and 50 – 75 % for sprinkler systems [6]. More than [7] noted that under China cnditions and mayze crop field ,the drip Irrigation systems was more efficient than sprinkler irrigation and sprinkler irrigation was more efficient than border/furrow irrigation.

Wetting patterns are primarily dictated by soil texture, soil tilth, structure also compaction and chemistry. In general, water from an emitter and exhibit more laterals, horizontal movement in heavier clay soils, and more vertical, downward movement in lighter sandy soils[8].

The use of closely spaced emitters is rapidly gaining in popularity thus, the ability to achieve superior wetting patterns more quickly than with wider spaced emitters [8] In this respect, the wetting patterns of emitters spaced at 12 and 8 inches, so, "wetted corridor of moisture" achieved down and across the bed after 30 hours of irrigation with the 8- inch spacing. therfore"blackening of the beds" is highly desirable by many growers.Under modern irrigation systems, especially when setting transplants or germinating seeds ,that was possible to increase soil water availability to enhanced vegetative and growth .

In general, irrigation management should focus in the adoption of practices that enhance the efficient use of water so that other sectors can have more water for economic use [9].

Previous studies showed that saving irrigation water, increasing water utilization efficiency as well as controlling irrigation was accompanied with enhancing growth and fruiting of grapevines and other fruit crops. Using modern methods of irrigation is considered an important target for achieving the benefits of water [6], [8], [10]-[17].

Weather parameters, crop characteristics, management and environmental aspects are factors affecting evaporation and Transpiration [18]At the same time a better management of water in irrigated agriculture it is necessary to enhance crop production and preserve soil and water quality [9].

The increment of water use from February until July may be attributed to the development of shoots, leaf area and clusters, as well as to the increase of evaporative demand. In addition the optimum water use of grapevine was 20, 35 and 23 L/vine/day from pruning to fruit set, fruit set to veraison and verasion to fruit maturation, respectively [15]. On other hand [19] observed that under different irrigation rates 100%, 80%, 70% and 60% of ETo, the amounts of water applied were 1060, 877, 763 and 649 mm/year, respectively. On 3 years old Superior vines with trickle irrigation. At the same time [20] studied the response of Cabernet sauvignon grapes to four irrigation treatments. The first at 100% of crop evapotranpiration (ETc) throughout the second at 40% ETc throughout the season but the thired no irrigation until veraison and 100% ETc applied throughout the rest of the season and the foruth treatmenes at 100% ETc from bud burst until veraison and no irrigation throughout the rest of the season. The amounts of water use were 4447, 1769, 1711 and 2700 m3/ha. for treatments no. 1,2,3 and 4, respectively. Furthermore [21] noted that Water consumptive use and crop coefficient were increased by increasing the amount of irrigation water applied from February up to November .In addition the Water consumptive use were 936.50, 749.16, 561.88 and 374.60 mm/ season . Meanwhile, annual crop coefficient were 0.75, 0.61, 0.50 and 0.43 when vines were irrigated at 125, 100, 75 and 50% ETpan, respectively.

The objective of this study was maximize water use efficiency through elucidating the effect of some trickle irrigation system treatments on enhancing growth, yield and water utilization efficiency in Superior vineyard orchards under Qena conditions.Alpha

II. MATERIALS AND METHODS

A. Experimental site description

This investigation was carried out during 2009 and 2010 seasons on 75 uniforms in vigor grapevines eight year's old Superior grapevines in vineyard located at a private orchard in ELQenwia Qena Governorate. The selected vines are trained according to cane pruning system (66 eyes for each vine as 6 fruiting canes x 9 eyes + 6 renewal spurs x two eyes) using shape supporting gable system. The vines are planted at 1.75 x 2.75 meters apart. Which gave (831 vine/fed.) Irrigation source is Nile water and its salinity was 0.36 (dS/m) pH =7.4 where the soil is salinity and Loamy sand. Mechanical, Physical and chemical characters of the tested soil analyses are shown in Table (I&II) were determined according to [22].

Table (I&II): Analysis of physical and chemical properties of the tested soil. Table (I): Some initial physical properties of the studied soil.

TABLE I
PHYSICAL CHARACTERISTICS

Depth	Particle size distribution			Texture	Bulk density g/cm3	Soil moisture constant (gm/gm)		
	Sand %	Silt %	Clay %		1.71	F. C	W.P	A.W
0-30	76.8	19.6	3.6	Loamy sand	1.65	0.15	0.06	0.09
30-60	44.8	51,6	3.6	Silt loam	1.65	0.24	0.08	0.16
60-90	60.7	34,5	4.8	Sandy loam	1.71	0.2	0.07	0.12

TABLE II
SOME INITIAL CHEMICAL PROPERTIES OF THE STUDIED SOIL

	pH 1:2.5	(ECs e).	$CaCO_3$	OM %	CEC	ESP	Available Macro Nutrients ppm		
Layer depth	PH	dS/m	%	%	meq/100g Soil	%	N	P	K
0-30cm	7.4	2.3	4.9	0.92	16.7	9.3	30	8	47
30-60cm	7.6	2.6	4.7	0.65	11.9	9.7	39	5	42
60-90cm	7.9	1.9	3.6	0.35	11.1	5.8	22	4	28

The successful production of grapes depended on irrigation management and irrigation water utilization efficiency [23]-[25]. Until now there is no recommended water requirement and irrigation scheduling in the new reclaimed land under drip irrigation system. There for a preliminary study was conducting during the seasons of 2006 to 2008 to calculate the average irrigation requirement for grape vine grown under this area . So this study was designed to determine the best system increasing water efficiency under drip irrigation system in the grape vine. The ability to estimate crop water use is important in semiarid areas such as Qena region where the production of crops are dependent upon the availability of irrigation water .In the present study it was favorably that to implement this work should be definite amount of water use through the average of the three previous study years 2006,2007 and 2008.

Table (III) shows the average three years of climatic data from 2006 to 2008 belonged to Qena area which collected from the meteorological station of South Valley Uni., reference evapotranspiration (ETO).

Data in Table (IV) indicated that in Qena region the average of three years ETo mm /month registered higher ETo 636mm in Jun, but the lowest in Dec, 186 mm ,while the total average on three years (2006 to 2008) recorded 4969.4mm /year. In 2009 and 2010 seasons used this average of the three years, of ETo as a based in water use during the two mentioned seasons.

B. Crop water requirements

Table (V) indicates the Applied water per vine and per feddan which was calculated from (ETo avg. 3 years) according to equation of [26] as ETc = ETo x Kc xGC% xPlant area/Ea) -pe.

Where: ETc = Applied irrigation water (liter/tree/day), ETo = Potential evapotranspiration (mm / day)

Kc = Crop coefficient from FAO56. and AgriMet Crop Coefficients [27] The crop coefficient is dependent upon stage of crop growth, canopy height, cover and architecture [18].

GC = Canopy cover represented by the shadow area average ranged between 0.32 in Feb. to 0.70 from May til Sep.

Canopy size measured by the amount of shade cast on the ground beneath grapevines growing.

Plant area = 2.75x1.75,.

Ea = Irrigation system efficiency (%) = 85 % for drip irrigation.

Pe = Effective rainfall (mm) = 0.30 rainfall. (L.R)

Leaching requirment = 0.36/2x12 =0.015 [28].

The crop coefficient (Kc) values were 0.15 (Feb.), 0.45, 0.75 and 0.45 (April, July and Oct,) and 0.35 in (November). under Qena condiation and Superior grapevines eight- years , gable system supporting The result indicated that total applied water during growing period 10428.3 L/vine/year ,while in unite of m it was 10.5 m3/vine per year. When using unit of area as Feddan (4200m2) the one feddan contains 831 vine and crop water requirements were 8665.7 m3/fed.

Experimental treatments and design: Irrigation was done by drip system. All the selected vines received the usual horticultural practices that already applied in the vineyard except those dealing with irrigation.

The present experiment included the following five treatments:

T1 One lateral and two emitters/ vine.
T2 One lateral and three emitters/ vine.
T3 Double laterals and two emitters/ vine.
T4 Double laterals and four emitters/ vine.
T5 Double laterals and six emitters/ vine.

Each treatment was replaced three times, five vines per each. All the selected vines received the same irrigation water amount namely 10. 5 m3/ vine/ year. The distance between laterals and vines were 2.75 and 1.75 meter, respectively.

TABLE III
METEOROLOGICAL DATA OF QENA REGION AVERAGE OF THREE YEARS FROM (2006 TO 2008)

Average	Dec	Nov	Oct	Sep	Aug	Jul	Jun	May	Apr	Mar	Feb	Jan	Elements avg. 3years
34.3	26.7	29.4	35.4	40.2	42.1	42.1	42.2	39.3	35.2	31.3	24.9	23.1	)°Max. Temperature (C
17.9	8.7	14.0	19.9	23.4	26.1	26.5	24.7	22.5	17.8	14.6	8.9	7.4	)°Min. Temperature(C
35	51	46	38	30	28	28	25	23	26	35	41	49	Relative Humidity (%)
5.9	4.8	4.6	5.7	6.7	7.3	6.7	6.7	6.7	6.1	6.0	5.2	4.5	Wind speed (m/s)
12.1	10.5	10.8	11.6	12.3	13	13.6	13.8	13.4	12.7	12.0	11.3	10.6	Sunshine hours (hr)
0.3	0.6	1.1	0.4	0.0	0.0	0.0	0.0	0.3	0.2	0.1	0.6	0.2	Total Rain (mm)
24.6	16.8	18.4	22.1	25.9	28.7	30.3	30.7	30	28.1	24.9	21	17.7	Rad MJ/m2 /day
13.59	6	8	12.6	16.4	18.3	18.2	21.2	19.1	16.2	12	8.3	6.2	Evapotranspiration (mm/day)

TABLE IV
AVERAGE EVAPOTRANSPIRATION ETO (MM/MONTH) FOR QENA REGION DURING 2006.TO2008

	Reference evapotranspiration ETo (mm/month)												
	Jan.	Feb.	March	April	May	Jun	Jul.	Aug.	Sep.	Oct.	Nov	Dec.	Total
2006	191.4	230.5	371.4	484.5	592.0	635.8	582.7	567.6	491.8	390.8	239.5	185.9	4963.9
2007	192.2	234.7	374.6	488.5	593.1	636.5	582.6	567.1	492.0	391.5	241.0	187.3	4981.1
2008	193.1	232.1	373.0	485.0	591.2	635.7	582.5	567.2	492.2	389.5	239.5	184.8	4965.8
Average	192.2	232.4	372.0	486.0	592.1	636.0	582.8	567.3	492.0	390.6	240.0	186.0	4969.4

TABLE V
AVERAGE VINEYARD EVAPOTRANSPIRATION ETO(MM/MONTH) AND WATER USE FOR QENA REGION DURING 2006.TO2008.

Dec.	Nov	Oct.	Sep.	Aug.	Jul.	Jun.	May	Apri	Mar.	Feb.	Jan.	
186.0	240.0	390.6	492.3	567.3	582.8	636.0	592.1	486.0	372.0	232.4	192.2	ETo(mm/day)average3 Years
0.0	0.35	0.45	0.55	0.7	0.75	0.75	0.65	0.45	0.25	0.15	0.0	Crop coefficient Kc (FAO)
0.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.66	0.65	0.32	0.0	Ground cover Redu.Fact. of
0.0	58.8	123.04	189.53	277.97	305.97	333.9	269.4	144.3	60.45	11.15	0.0	ETc loc mm/month
1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	Eu application emission uniformity
0.0	68.8	144.0	221.8	325.2	358.0	397.7	315.2	168.8	70.7	13.04	0.0	IRg mm/month gross irrigation
0.0	331.1	693.0	1067.4	1565	1723	1914	1517	812.3	340.2	62.76	0.0	IRg1 L/vine/month
0.0	336.1	703.4	1083.4	1588.5	1749.0	1943.0	1540.0	824.5	345.3	63.61	0.0	L.R(0.015)
0.0	11.2	22.7	36.1	51.24	56.42	64.8	49.7	27.48	11.1	2.3	0.0	IRg3 L/vine/day
10428.3L/vine/year												total applied water per year
10.5m3/year/vine												
8665.7												m3/year/feddan

TABLE VI
OPERATING TIMES (HRS) IN THE FIVE TRICKLE IRRIGATION SYSTEM DURING THE PERIOD FROM JAN TO SEPT. IN BOTH SEASONS.

Month Treatment	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
T1	0.0	0.29	1.38	3.44	6.21	8.10	7.05	6.41	4.52	2.84	1.40
T2	0.0	0.19	0.90	2.29	4.14	5.40	4.70	4.27	3.00	1.89	0.93
T3	0.0	0.29	1.38	3.44	6.21	8.10	7.05	6.41	4.52	2.84	1.40
T4	0.0	0.14	0.70	1.72	3.12	4.05	3.53	3.20	2.26	1.42	0.70
T4	0.0	0.10	0.46	1.15	2.10	2.70	2.35	2.14	1.50	0.95	0.47

Emitters discharge was four L/ hr. Operating times (hrs) in the present five treatments are shown in Table (VI).

Emitter discharge was 4liter/ hr .Irrigation water amount 9.4 m3/ yr/ vine for all treatments. Complete randomized block design was adopted for statistical analysis of the present results. Main shoot length (cm.) was measured at the middle of May in the two in eight main shoots in all directions of the vines.

Leaf area (cm2) was estimated in twenty leaves per vine from those leaves apposite to the first clusters on each shoot (mid. of May) and leaf area (cm2) was recorded according to the following equations reported by [29]

Leaf area (cm2) = 0.45 (0.79 x w2) + 17.77

Where W = the maximum diameter (cm2).

Petioles of these leaves were saved, oven dried and grounded then 0.5 g weight of each sample was digested using H2SO4 and H2O until clear solution was obtained. The digested solution was quantitively transferred to 100 ml volumetric flask and completed to 100 ml by distilled water. Therefore leaf content of N, P, K, Mg and S (as percentages) and Zn, Fe and Mn (as ppm) in the samples were determined according to the methods that outlined in [30].

Berry set % was calculated by dividing the number of attached berries in the caged clusters by the total number of flowers/ cluster and multiplying the product by 100.

Harvesting was conducted (mid. of June) when T.S.S/ acid reached at least 24 – 26 (According to [12]. The yield per vine was recorded in terms of weight (kg.) and number of clusters per vine. Five clusters were taken at random from the yield of each vine for determination of cluster weight (g.) as well as the following physical and chemical characteristics of the grapes.

1. Percentage of shot berries by dividing number of small berries by total number of berries per cluster and multiplying the product x 100.
2. Percentage of total soluble solids in the juice.
3. Percentage of total acidity (expressed as g. of tartaric acid/100 ml of juice) by titration against 0.1 N NaOH using phenolphthalein as indicator [38].
4. Total soluble solids/ acid.
5. Percentage of total sugars in the juice [31].

Water utilization efficiency (WUE) yield (kg.)/ m3 water was estimated by dividing total yield per vine by applied water (m3)/ vine/ year.

Statistical analysis: All the obtained data were tabulated and subjected to the proper statistical analysis according to [32].using new L.S.D test at 5 % for comparing between means of all treatments.

III. RESULTS AND DISCUSSION

A. Meteorological Data

Qena Governorate locates in South Egypt (Longitude 32.44, latitude 26.11 and 74.2 meter above sea level). Meteorological data were collected for a period of three years (2006-2008)of the studied area in order to detect the the effect of different laterals and emitters frequencie emitters frequencie on growth “or yield”, leaf contents of representative macro and micro nutrients, berry setting %, and phonological characteristics of Superior vineyards’. The data from (Table V) represented that the average water consumptive recorded 10.5 m3/year/vine under Qena condition In 2009and 2010 seasons the average of evapotranspiration of the three years prior of this study were used . Data presented in (Table III) showed that the highest value of evapotranspiration in June was 21.2 mm/day which resulted to water consumptive of 64.8 liter/day/vine, the lowest value of evapotranspiration recorded in Jan, and Dec, were 6.2 and 6.0 mm/day respectively (without irrigation). Meanwhile water consumptive recorded 11.1, 27.48, 49.7, 56.42, 51.24, 36.1, 22.7 and 11.2 liter/day in Mar, Apr, May, Jul, Aug, Sep, Oct and Nov, respectively. As a result, Grapevine water use and Kc started from Feb. to Nov. This finding were agreement with [27] and [21] which noted that the amount of irrigation water 5, 11, 19, 33, 37, 34, 30, 26, 18 and 13 (L/day /vine) can be applied during February up to November, respectively. And also the previous results were in agreed with [19], [20] and [33].

In general, under arid climates evapotranspiration is above 200 mm yr-1, so the total amount of water required for irrigation varies from climate to climate.[4]. And also, crop growth and second yield are not possible without irrigation after the final grape product [34]; [35]. Meanwhile [35] observed that WUE can be improved by drip irrigation system which more effective than sprinkler irrigation. Moreover saving of WUE about 25% may be due to a reduced wetted soil volume under sandy soil. The optimum response was obtained when irrigation about 90 mm at veraison in Barlinka grapes. Moreover[6], [7] and [37] they noted that drip irrigation systems often achieve over 90 % uniformity with proper design, installation and maintenance. This is in contrast to typica1 uniformities of 40 – 60 for gravity systems and 50 – 75 % for sprinkler systems.In this respect [33] they reveld that the accumulated actual evapotranspiration (ET) from pruning to harvest in wine grape was 438 and 517 mm for the first and second Growing cycles, respectively.In addition, table grape consumed less water than wine grape (393 and 352 mm) for the first and second growing seasons, respectively this result due to the shorter crop stages.On the other hand,these resultes were not agreement with those obtaind by [38] which observed that flowering was advancement under low water irrigation this result may be due to modifications in the plant hormonal balance due to root signal which eventually led to earlier flower induction.

According to these results, using drip irrigation system were studied using amount of water 8665.7. m3 /year on eight year's old Superior grapevines grown at 1.75 X 2.75 m apart in sandy loam soil under Qena conditions.The number of laterals and emitters per vine ranged from one to two and from two to six/ vine, respectively. The merit was enhancing irrigation water utilization efficiency in Superior vineyards, this comes later as a results.

B. Leaf Area And Its Content From N, P, K, Mg, S, Zn, Fe And Mn In The Leaves

Data in Table (VII) clearly show that leaf area significant differences by the number of laterals and emitters per vine and its content of N, P, K, Mg, S, Zn, Fe and Mn .Increasing frequencies of laterals from one to two and at the same time number of emitters from two to four significantly was followed on leaf area .In this respect the highest value was observed in (T5) using irrigation treatment Double laterals and six emitters/ vine registrated 87.0 and 79.5 (cm2) in the first and second seasons respectively,at the same time (T4) Double laterals and four emitters/ vine were less effective and no significant with (T5) during the sucssive seasons.Meanwhil the lowest values in leaf area were obtaind in (T1) One lateral and two emitters/ vine which recorded 71.1 and 72.2 cm2 in the first and second seasons respectively,at the same time leaf area recorded the intermediate value under drip irrigation using (T3) Double laterals and two emitters/ vine it recorded 74.5 and 77.5 cm2 during the first and second studied seasons.

From the abovementiond results it could be concluded that the optimum release of water under wetted area surely reflected on supplying the vines with their requirements from water and nutrients at different stages of growth and grape development and these explain the present effects of increasing number of laterals and emitters for each vine [6]. These results are in agreement with those obtained by [15], [17], [7], [3], [5], [33], [25] and [4].

Also data in Table (VII) show considerable differences in main shoot length as well as leaf content of N, P, K, Mg, S, Zn, Fe and Mn. Using number of laterals and emitters per vine .The results reveal that main shoot length gradually increased by increasing the laterals and emitters per vine.Therfor , the best result was noticed when Superior vineyards irrigated using Double laterals and six emitters/ vine (T5) it recorded 107.2 and 108.1(cm) during the firest and second seasons respectively,under this conditions main shoot length was less than (T5) and no significant under drip irrigation by using (T4) Double laterals and four emitters/ vine. On the other hand , one lateral with two emitters (T1) registrited the lowest value 96.0 and 98.0 (cm) in main shoot length during the two seasons respectively,. The intermediate values were noticed on (T2) and (T3)respectively ,they recorded 99.5 &101.1 and 103.3&104.0 cm during the first and second seasons.

From the data in Table (VII) leaf content of N, P, K, Mg, S, Zn, Fe and Mn.Gives the same direction in the abovementioned results (leaf area and main shoot length) thus, using double laterals with two emitters significantly superior than application of one lateral with two emitters in enhancing these parameters. Increasing number of emitters from four to six on double laterals failed to show significant promotion on growth characters and these nutrients. The minimum values were recorded on the vines that received water as one lateral with two emitters/ vine (T1) the macro nutrients (N% , P% and K%) in leaf (1.92 & 1.94 N%), (0.16 & 0.18 P%) and (1.81 & 1.89 K%) during the firest and second seasons respectively, . So Using double laterals and six emitters/ vine(T6) gave the maximum values in leaf miniral cntent which were(2.17 & 2.18 N%), (0.25 & 0.29 P%) and (2.14 & 2.23 K%) . These results were true during the two seasons respectively. Meanwhile the intermediate effectes were noticed with (T3) which recorded (2.1 & 2.09 N%), (0.21 & 0.25 P%) and (2.01 & 2.11 K%) . The same line were noticed with this treatments on micro nutrients,i.e. leaf content % of Mg, S, Zn, Fe and Mn.

Differences between treatments my be attributed to increasing the number of laterals and emitters per vine increased the wetted area surely reflected on supplying the vines with their requirements from water at different nutrients elements by rooting system consequntly , increased macro and micro elements and plant hormone accumulation during growth and grape development [6].

The present results agree well those of [14], [15], [17], [33] and [25].

C. Berry Setting %

Data in Table (VIII) obviously show that there was a gradual and significant promotion on the percentages of berry setting % of Superior grapevines with increasing number of laterals from one to two as well as frequency of emitters per vine from two to six. Berry setting % was significantly maximized with using two emitters per vine on double laterals comparing with using the same number of emitters with one lateral. Significant differences on the berry setting % were observed among the five drip irrigation treatments except among the last two treatments (four or six emitters situated on double laterals). In this respect, the maximum values were recorded on the vines that irrigated through drip irrigation through using double laterals with six emitters (T5) (14.3% and 15.5 %)durig the first and second seasons respectively. In contrast, using one lateral and two emitters/ vine (T1) gave the lowest values (11.0% and 11.5 %) berry setting durig the first and second seasons respectively,meanwhile the intermediate effective in berry setting % of Superior grapevines was ntoticed in (T3) Double laterals and two emitters/ vine(13.9 and 14.1) in the two studied seasons.

Regardling the beneficial effect of adjusting drip irrigation (selecting two laterals and four to six emitters/ vine) on berry setting might be attributed to its positive effect on stimulating growth and vine nutritional status in favour of producing in or berry on each cluster. Similar results were announced by [15], [34], [35] and [25].

D. Number Of Cluster / Vine

Response the number of cluster / vine to the number of laterals and emitters per vine ranged from one to two and from two to six/ vine, respectively.In Table (VII) no significant differences on number of cluster / vine were observed among the five drip irrigation treatments in the first seasons only .However , the last two treatments(T4) and (T5) ((four or six emitters situated on double laterals) recorded the highest values (23 and 23 cluster / vine) in the first seasons.While the same comparison in the second season the significan clearly showed between laterals .The possitive effective response was recorded in (T5), (T4) and (T3) were(24 cluster / vine) per each treatments.On the other hand smaller response was observed on in (T2) One lateral and three emitters/ vine (23 cluster / vine) .It would appear worth while to note that the the positive effect of increasing laterals and emitters per vine was more effective in increased the wetted area surely reflected on supplying the vines with their requirements from water at different nutrients elements obsebation lead to increased macro and micro elements and plant hormone accumulation during growth and grape development [6].

These results could be directly confirmed with the finding of [15], [34], [35]and [25].

E. Yield And Cluster Weight :

It is evident from the data in Table (VIII) that varying number of laterals and emitters per vine in drip irrigation system had significant effect on the yield expressed in yield/vine and cluster weight. Increasing number of laterals (from one to two) and emitters per vine (from two to six) caused a significant and gradual promotion on the yields and cluster weight .Thus the best results were observed in (T5) double laterals with six emitters (10.6 kg/ vine) in both seasons , followed by and not significal in (T4) double laterals with four emitters (10.0 and 10.6 kg/ vine)during the first and second seasons respectively . In this respect double laterals with two emitters per vine had significant variation and entermediate effect on yield (8.9 and 9.1 kg/ vine) during the first and second seasons respectively . So, using double laterals with / vine was preferable than using one lateral which recorded (6.9& 6.9) and (7.8 & 8.0) kg/ vine under two and three emitters per vine during the first and second seasons respectively. Meaningless promotion on yield and cluster weight was observed with increasing number of emitters per vine from four to six on double laterals.

At the same time, cluster weight (g) in Table (VIII) prssented that the recommendation was the application of double laterals with four emitters/ vine(T4) . Under such promised treatment, reached (434.8 and 437.5 (g)/cluster) during the two studied seasons, respectively. However,the best resultes was noticed in(T5) double laterals with six emitters reashed (460.9 and 441.7 (g)/cluster). In this respect, vines subjected to drip irrigation through (T1) one lateral and two emitters/ vine gave minimum and significantly cluster weight (g) reached (313.6 and 328.6) during the two studied seasons.The intermediate value and significantly cluster weight (g) was noticed in (T3) Double laterals and two emitters/ vine (404.5 and 397.2)followed by (T2) One lateral and three emitters/ vine(354.5 and 347.8) durig the first and second seasons respectively.

These results might be attributed to the positive action of adjusting drip irrigation system on berry setting, cluster weight and cluster number previously mentioned. [14], [15], [34], [35], [33], [13], [25], [17]. And also [39] reported that when only a portion of the root zone is wetted, the water absorption by the wetted roots increases relative to the amount absorbed by the portion when the whole root systems wetted i.e. increasing the efficiency of water uptake. On the other hand ,these resultes were not agreement with those obtaind by [38] stated that flowering was advancement under low water irrigation this result may be due to modifications in the plant.

F. Shoot Berries %:

It was gradually reduced with increasing laterals and emitters frequency. Using double laterals with six emitters per vine (T5) gave the lowest values in Shoot berries %(3.9 and 3.5) while no significant reduction on shot berries % was observed with increasing number of emitters per per vine from four(T4) to six (T5) on double laterals. These results were true during both. In this respect the highest values in shoot berries % recorded in (T1) one lateral and two emitters/ vine (8.1 and 8.3) during the firest and second studied seasons ,the enhancement in shoot berries % medium effect and significant reduction was noticed in (T3) double lateral and two emitters/ vine were(5.0 and 4.9) followed by (T2) One lateral and three emitters/ vine(6.1 and 6.0) durig the two studied seasons .

The beneficial of selecting the best system of drip irrigation on the availability of water to all plant organs at the specific stage of berries development surely reflected on reducing shot berries phenomenon.

G. Physical and chemical characteristics of the berries:

The results of [12], [35], [17], [39] and [25] they emphasized the present results.

It is clear from the data in Table (VIII) that carrying out drip irrigation by increasing number of laterals from one to two as well as number of emitters from two to six per vine significantly was accompanied with improving quality of the berries in terms of increasing berry weigh(g).Therefore,it was found suitable and no statistical significant response to influence of laterals and emitters frequency on the berry weight on(T5) and (T4) in dessinding order they recorded (3,16 &3,26) and(3,15 &3,25 g) in both treatments during the first and second seasons respectively. In contrast and statistical significant response was found in single lateral (T1) and (T2) in assinding order they recorded (2,81 &2,82) and (2,95&2,96 g) in both treatments during the tow studied seasons respectively.On theother hand,the medium effects was noticed in (T3)which rigestrated (3,05 and 3,1 g) this results held well during the two studied seasons .

Total soluble solids %, T.S.S/ acid and total sugars % and decreasing total acidity %. A slight and insignificant promotion on both physical and chemical characteristics of the grapes was observed with increasing number of emitters from four to six at double laterals. Therefore, the recommendation was carrying out drip irrigation with using (T4) double laterals and four emitters per vine, was the best treatments in total soluble solids %. In the mean time the total soluble solids %, recorded the intermediate values with (T5) and (T3) (19,0 &20,0) and (19,7 and 20,0) during the first and second seasons respectively, in both treatments .Meanwhil (T2) and (T1) recorded the lowest values in dissending order in this respect. These results were true during 2009 and 2010 seasons.

Concerning T.S.S/ acid , total sugars % and decreasing total acidity data presented in(Table VII). Successful forecasting of the T.S.S/ acid and total sugars % and decreasing total acidity,in Superior grapevines usig drip irrigation with (T4) four emitters per vine on double laterals comparing with using any other treatments.At the same time the total acidity% was higher under (T1)follwed by(T2) in dessinding order in this respect. Medium effect in total acidity% were noticed in (T3)and (T5) in assinding order.Results were similler trend in T.S.S/ acid.On the other hand, total sugars % recorded the medium effects by using (T3)and (T5) in dessinding order.In this respect the lowest value obtaind in(T1)follwed by(T2) in dessinding order. These results were true during 2009 and 2010 seas the beneficial effect of adjusting ons by increasing the number of laterals and emitters per vine. These results may be due to

the beneficial effect of adjusting the method of drip irrigation on enhancing the availability of water especially during critical levels of plant development surely in enhancing the biosynthesis of carbohydrates and encouraging cell division [11].

The results were agree with those by [12], [35], [17], [39] and [25] they emphasized the present results.

H. Water Utilization Efficiency (Wue) Yield (Kg.)/ M3 Water

Table (IX) show that WUE was significantly increased with using laterals from one to two and emitters from two to six per vine. Using (T2) one lateral with three emitters/ vine significantly improved WUE rather than using (T1) one lateral with two emitters per vine. No major and significant promotion on WUE was observed with increasing number of emitters from four to six or double laterals. Therefore, the recommendation was the application of two laterals with six emitters/ vine (T5) such promised treatment, WUE reached 1.01 kg yield/ m3. The lowest WUE observed by using (T1) one lateral with two emitters regestirated 0.66 kg yield/ m3. Similar results were declared during both seasons.

The great promotion on the yield and the same time for the reduction of water consumption surely reflected on enhancing WUE.

Similar results were announced by [16], [17], [3], [8], [5] and [25] . In this respect [33] observed that the accumulated actual evapotranspiration (ET) from pruning to harvest in wine grape was 438 and 517 mm for the first and second Growing cycles, respectively.In addition, table grape consumed less water than wine grape (393 and 352 mm) for the first and second growing seasons, respectively this result due to the shorter crop stages.On the other hand,these resultes were not agreement with those obtaind by [38] which observed that flowering was advancement under low water irrigation this result may be due to modifications in the plant hormonal balance due to root signal which eventually led to earlier flower induction. As a conclusion, for promoting irrigation water utilization efficiency in Superior vineyards and at the same time improving yield quantitively and qualitatively, it is suggested to follow up drip irrigation on the bases of double laterals and four or six emitters/ vine.

TABLE VII
INFLUENCE OF LATERALS AND EMITTERS FREQUENCY ON THE LEAF AREA, MAIN SHOOT LENGTH AND ITS CONTENT OF N, P, K, MG AND S (AS PERCENTAGES), ZN, FE AND MN (AS PPM) OF SUPERIOR GRAPEVINES DURING 2009 AND 2008 SEASONS.

Treatments	Leaf area (cm2)		Main shoot length (cm.)		Leaf N %		Leaf P %		Leaf K %	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
T1.	71.1	72.2	96.0	98.0	1.92	1.94	0.16	0.18	1.81	1.89
T2	73.3	75.0	99.5	101.1	1.99	2.01	0.18	0.21	1.91	1.96
T3	74.5	77.5	103.3	104.0	2.10	2.09	0.21	0.25	2.01	2.11
T4	77.8	79.3	107.1	108.0	2.16	2.17	0.24	0.28	2.12	2.22
T5	78.0	79.5	107.2	108.1	2.17	2.18	0.25	0.29	2.14	2.23
New L.S.D at 5 %	1.1	1.2	1.7	1.9	0.06	0.05	0.02	0.02	0.07	0.06
Treatments	Leaf Mg %		Leaf S %		Leaf Zn (ppm)		Leaf Fe (ppm)		Leaf Mn (ppm)	
T1	0.30	0.33	0.41	0.42	51.0	52.0	29.2	30.0	29.0	30.0
T2.	0.39	0.41	0.45	0.46	55.0	57.0	33.0	34.0	35.0	33.0
T3	0.42	0.44	0.50	0.50	60.0	61.9	36.0	38.0	40.0	39.9
T4	0.44	0.48	0.55	0.56	66.0	66.6	40.0	41.5	45.0	46.3
T5	0.45	0.49	0.56	0.57	67.5	68.0	41.0	42.0	46.0	47.0
New L.S.D at 5 %	0.02	0.02	0.02	0.02	2.2	2.3	2.4	2.5	2.5	2.5

(T1) One lateral and two emitters/ vine , (T2) One lateral and three emitters/ vine, (T3) Double laterals and two emitters/ vine. (T4) Double laterals and four emitters/ vine ,(T5) Doubl laterals and six emitters/ vine. ,

TABLE VIII
INFLUENCE OF LATERALS AND EMITTERS FREQUENCY ON BERRY SETTING %, YIELD, cLUSTER WEIGHT (g.), SHOOT BERRIES % AS WELL AS SOME PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE BERRIES oF SUPERIOR GRAPEVINES DURING 2007 AND 2010 SEASONS

Treatme nts	Berry setting %		No. of clusters/ vine		Yield/ vine (kg.)		Cluster weight (g.)		Shoot berries %	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
T1	11.0	11.5	22.0	21.0	6.9	6.9	313.6	328.6	8.1	8.3
T2	12.1	12.8	22.0	23.0	7.8	8.0	354.5	347.8	6.1	6.0
T3	13.9	14.1	22.0	24.0	8.9	9.1	404.5	397.2	5.0	4.9
T4	14.2	15.3	23.0	24.0	10.0	10.5	434.8	437.5	3.9	3.7
T5	14.3	15.5	23.0	24.0	10.6	10.6	460.9	441.7	3.9	3.5
New L.S.D at 5 %	1.0	1.0	NS	1.0	0.7	0.9	30.1	31.0	0.9	0.8
Treatme nts	Berry weight (g.)		T.S.S %		Total acidity %		T.S.S/ acid		Total sugars %	
T1	2.81	2.82	18.0	18.0	0.711	0.712	25.3	25.3	16.0	16.1
T2	2.95	2.96	18.5	18.7	0.681	0.671	27.2	27.9	16.8	16.9
T3	3.05	3.10	19.0	19.5	0.651	0.641	29.2	30.4	17.3	17.5
T4	3.15	3.25	19.7	20.9	0.628	0.600	31.4	34.8	17.8	18.2
T5	3.16	3.27	19.0	20.0	0.661	0.631	28.7	31.7	16.5	17.1

(T1) One lateral and two emitters/ vine , (T2) One lateral and three emitters/ vine, (T3) Double laterals and two emitters/ vine. (T4) Double laterals and four emitters/ vine ,(T5) Double laterals and six emitters/ vine. ,

Table IX

Effect of laterals and emitters frequency on water utilization efficiency (WUE) in Superior vinyards during 2009and 2010 seasons

Treatments	2009			2010		
	Yield / vine (kg.)	Applied water m3/vine/yr.	WUE/ yield/ m3	Yield/vine (kg.)	Applied water m3/ vine/ yr.	WUE/ yield/ m3
T1	6.9	10. 5	0.66	6.9	10. 5	0.66
T2.	7.8	10. 5	0.74	8.0	10. 5	0.76
T3	8.9	10. 5	0.85	9.1	10. 5	0.87
T4	10.0	10. 5	0.95	10.5	10. 5	1.00
T5	10.6	10. 5	1.01	10.6	10. 5	1.01

(T1) One lateral and two emitters/ vine , (T2) One lateral and three emitters/ vine, (T3) Double laterals and two emitters/ vine.

(T4) Double laterals and four emitters/ vine ,(T5) Double laterals and six emitters/ vine. ,

REFERENCES

[1] Beaumont, P., 1993. Drylands Environmental Management and Development. Routledge, London and New York.

[2] Hassan, M.M., M.A. Salama, A.A. Moustafa, M.M. El-Sayed and G.A.A. El-Samad, 1999. Water use, water use efficiency, crop coefficient and yield of olive trees as affected by irrigation regimes. J. King Abdulaziz Univ. Meteorol. Environ. Arid Land Agric. Sci., 10: 45-54.

[3] El-Hady, O.A. and A.A. Abd El- Kader, 2003. Nutrients uptake and water and fertilizers use efficiency by vine grapes grown on a newly reclaimed sandy area as affected by uniformity of emission. Egypt. J. Soil Sci., 43: 577-588.

[4] De Oliveira, A.S., R. Trezza, E.A. Holzapfel, I. Lorite and V.P.S. Paz, 2009. Irrigation water management in Latin America. Chilean J. Agric. Res., Vol. 69.

[5] De la Hera, M.L., P. Romero, E. Gomez-Plaza and A. Martinez, 2007. Is partial root-zone drying an effective irrigation technique to improve water in field-grown winegrapes under semiarid conditions?. Agric. Water Manage., 87: 261–274.

[6] Caswel, M. and D. Zilbernian, 1985. The choices of irrigation technologies in California. Am. J. Agric. Econ., 67: 224-234.

[7] Zhang, Y., E. Kendy, Y. Qiang, L. Changming, S. Yanjun and S. Hongyong, 2004. Effect of soil water deficit on evapotranspiration, crop yield, and water use efficiency in the North China Plain Agric. Water Manage., 64 (2004), pp. 107–122.

[8] Gal, A., N. Lazorovitch, and U. Shani, 2004. Subsurface drip irrigation in Gravel filled cavities. Vadose Zone J., 3: 1407 -1413.

[9] CAWMA, 2007. Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture. Earthscan and Colombo: International Water Management Institute, London, UK.

[10] Winkler, A.J., 1965. General Viticulture. University of California Press, Berkley and Los Angeles, pp: 50-90.

[11] Winkler, A.J., A.J. Cook, W.M. Kliewer and L.A. Lider, 1974. General Viticulture. California University Press, Berkley Los Anglos, London, pp: 10-200.

[12] Weaver, R.J., 1976. Grape Growing. John Wiley and Davis, New York, London, Sydney, Tronto, pp: 160-175.

[13] Donaire, J., A.J. Sanchez-Raya, J.L. Lopez-George and L. Recalde, 1977. Studies physiological and biochemestry in olivier: I.variation in concentration de divers metabolites pendant son cycle evolutif. Agrochim 21:311–321.

[14] Peacock, W.L., D.E. Rolston, F.K. Aljibury and R.S. Rauschkolb, 1977. Evaluating drip flood and sprinkler irrigation of wine grapes. Am. Soc. Enol. Vitic., 28: 193 – 195.

[15] Hepner, Y., B. Bravdo, C. Loinger, S. Cohen and H. Tabacman, 1985. Effect of drip irrigation schedules on growth, yield, must composition and wine quality of Cabernet Sauvignon. Ann. J. Ebol. Vitic., 36: 77-85.

[16] Araujo, F., L.E. Williams, D.W. Grimes and M.A. Matthews, 1995. A comparative study of young Thompson Seedless grapevines under drip and furrow irrigation. I. Root and soil water distributions. Sci. Hortic., 60: 235-249.

[17] Mccarthy, M.G., R.M. Cirami and D.G. Furkalicy, 1997. Rootstock response of Shiraz (<I>Vitis vinifera</I> L.) grapevines to dry and drip irrigated conditions. Aust. J. Grape Wine Res., 3: 95-98.

[18] Allen, R.G., L.S. Pereira, D. Raes and M. Smith, 1998. Crop Evapotranspiration Guidelines for Computing Crop Water Requirements. Food and Agriculture Organization, Rome, Italy, pp: 297.

[19] Serman, F.V., M. Liotta and C. Parera, 2004. Effects of Irrigation deficit on Table grape Cv. Superior Seedless Production. Acta Hortic., 646: 183-186.

[20] Fereyra, R., V. Selles, A. Perlata and B. Valenzuela, 2004. Effect of water stress applied at different development periods of cabenert sauvignon grapevine on Production and wine quality. Acta Horticulturae, 646: 27- 33.

[21] Seif, S.A., G.A. Abd-El Samad, M.E. Morsi and H.R. Hussein, 2007. Effects of different irrigation regimes on some grapevine cultivars grown under new reclaimed land conditions. 1-Water consumptive use, crop coefficient, water use efficiency and productivity. Annals of Agric.Sc., Moshtohor, 45(1): 353- 368.

[22] Richards, L.A., 1954. Diagnosis and Improvement of Saline and Alkali Soils. Regional Salinity Laboratory, Washington, DC., USA.

[23] Kang, S and J. Zhang, 2004. Controlled alternate partial root- zone irrigation: Its physiological consequences and impact on water use efficiency. J. Exp. Bot., 55: 2437-2446.

[24] Loveys, B.R., P.R. Dry, M. Stoll and M.G. Mccarthy, 2005. Using plant physiology to improve the water use efficiency of horticultural crops. Acta Hortic., 537: 187-197.

[25] Stevens, R.M., G. Harvey and D. Apsinall, 2008. Grapevines growth of shoots and fruit linearly correlate with water stress indices based on root-weighted soil metric potential. Aust. J. Grape. Wine Res., 1: 58-66.

[26] Doorenbos, J. and W.O. Pruitt, 1984. In crop water requirements. Irrig. & Drain. Paper No. 24, FAO, Rome, Italy.

[27] http://www.usbr.gov/pn/agrimet/cropcurves/WGRPcc.html

[28] Walker, R and R. Stevens, 2004. Recent Developments in the Understanding of the Effects of Salinity on Grapevines. In: Salinity Impact on Lower Murray Horticulture- Milestone, Schrale, G. and T.K. Biswas (Eds.). Water Resources and Irrigation, SARDI, Adelaide, Australia, pp: 1-16.

[29] Ahmed, F.F. and M.H. Morsy, 1999. A new methods for measuring leaf area in different fruit species. Minia, J. of Agric. Res., Develop. 19 pp. 97-105.

[30] Wilde, S.A., R.B. Corey, J.G. Layer and G.K. Voigt, 1985. Soils and Plant Analysis for Tree Culture. Oxford and IBH Publishing Co., New Delhi, India.

[31] AOAC, 1995. Official Methods of Analysis. 14th Ed, Association of Official Analytical Chemistry, Washington, DC., USA., pp: 490-510.

[32] Mead, R., R.N. Currnow and A.M. Harted, 1993. Statistical Methods in Agricultural and Experimental Biology. 2nd Edn., Chapman and Hall, London, UK., pp: 54-60.

[33] Teixeira, A.H., W.G.M. Bastiaanssen and L.H. Bassoi,. 2007. parameters of irrigated wine and table grapes to support water productivity analysis in the Sao Francisco river basin, Brazil. Agric. Water Manage., 94 : 31 – 42.

[34] Martin, D.L. and J.R. Gilley, 1993. Irrigation Water Requirements. In: National Engineering Handbook: Section 15, Irrigation, USDA (Ed.). Chapter 2. USDA-Soil Conservation Service (SCS), Washington, DC., USA.

[35] Williams, L.E. and M.A. Matthews, 1990. Grapevine. In: Irrigation of Agricultural Crops-Agronomy Monograph, Stewart, B.A. and D.R. Nielson (Eds.). ASA-CSSA-SSSA, Madison, WI., USA., pp: 1019-1059.

[36] Saayman, D. and J.J.N. Lambrechts, 1995. The effect of irrigation system and crop load on the vigour of Barlinka Table Grapes on a sandy soil, Hex River valley. S. Afr. J. Enol. Vitic., 16: 26-34.

[37] De la Hera, M.L., P. Romero, E. Gomez-Plaza and A. Martinez, 2007. Is partial root-zone drying an effective irrigation technique to improve water in field-grown field-grown winegrapes under semiarid conditions?. Agric. Water Manage., 87: 261–274.

[38] Cuevas, J., L.C. Maria, V. Pinillos, J.Z. Antonio, M.D. Fernadez, M. Gonzalez and J.J. Huso, 2007). Optimal dates for regulated deficit irrigation in Algerie loquat (<I>Eriobortya japonica</I> L.) cultivated in Southeast Spain. Agric. Water Manage., 89: 131-136.

[39] Glenn, D.M., 2000. Physiological effects of incomplete root zone wetting on plant growth and their implications for irrigation management. HortScience, 35: 1041-1042.