December 2009 Volume 4 Issue 6

Trade Science Inc.

Environmental Science
An Indian Journal

Current Research Papers

ESAIJ, 4(6), 2009 [403-411]

Effect of some anti-evaporative and anti-transpirant on water use efficiency of fig trees

Evon K.Rizk

Soil Physics and Chemistry Department, Desert Research Center, El-Matareya, Cairo, (EGYPT)

E-mail : s.sedhom@yahoo.com

Received: 17th June, 2009 ; Accepted: 27th June, 2009

ABSTRACT

This work is a trial to improve water use efficiency of fig orchards grown in sandy soils of North Sinai area through mulching and anti-transpirant under water management. The applied treatments include: main plots as three irrigation intervals: (I_1= 1 day, I_2= 2 days & I_3= 4 days) with irrigation amounts calculated according to Penman-Monteith equation and sub-main plots as four soil-plant management treatments: (control without additions, black plastic mulch (BPM), spry Abscisic acid (ABA) 10% w/w & combined BPM + ABA). The study was conducted in split plot design with three replicates for each treatment. The results were analysed statistically (ANOVA and L.S.D.). The experimentalwork reveals increases in fig fruit yeild, water use efficiency and water economy by increasing irrigation intervals and adding combined BPM + ABA, but the reverse was observed for water consumptive use, crop coefficient and beneficiary factor. The highest values of fig fruit yeild, water use efficiency and water economy were obtained by irrigation every 4 days and application combined BPM + ABA. Likewise, those treatments led to the lowest values of water consumptive use, crop coefficient and beneficiary factor. From the previous findings, one can conclude that irrigation every 4 days and use of black plastic mulch under fig trees are recommended in light of the highest investment ratio at the prevailing conditions in the study area. Those treatments have also saved water consumption by about 19 %.

KEYWORDS

Irrigation water management;
Black plastic mulch;
Abscisic acid;
Fig orchards;
Water use efficiency.

INTRODUCTION

Several practices are directed to restricting the losses of water and maximizing the benefit of limited water resource. Among these, irrigation water management, mulching and use of antitranspirants have been devoted special attentions plastic mulching in combination with drip irrigation and nutrients injection (fertigation) enhance water and nutrient use effeciency[2]. Mulching is a simple technique to minimize water evaporation from the rhizosphere zone, directly affect the microclimate around the plant by modifying the radiation budget of the surface and decreasing the soil water loss[10], favours root development and raise temperature in the planting bed, promoting faster crop development and earlier harvest, Lamont[9] as well as weed control, Allen et al.[1]. Besides, black polyethelene is used for its easy processing, excellent chemical resistance, high durability, flexibility and odourless, Wright[27] and Espý´ et al.[4].

Antitranspirants include both film forming and stomata closing compounds that increase the leaf resistance to water vapor loss thus improving plant water use to assimilate carbon and, in turn, the production of biomass or yield, Plaut et al.[12], Tambussi and Bort[25] and Marcello et al.[11]. Beside their low environmental impact and economic cost, they counteract occasional and episodic drought events, resistant inducer against plant viruses[5,8,13], promising non-toxic fungicides[22,23,26], ameliorate the fruit quality under storage conditions[17] and limit the water loss deputed to evaporative leaf cooling[6].

Since fig trees (*Ficus carica L.*) are widely spread in countries possessing Mediterranean climate and has edible fruits attaining excellent source of minerals, vitamins and dietary fibre; high number of amino acids being fat and cholesterol-free[18,21], fig was selected for study.

The main objective of the present study is to investigate the effect of mulching and anti-transpirant under irrigation water management of sandy soils on water use efficiency of fig orchards grown in the desert environments of North Sinai, Egypt.

MATERIALS AND METHODS

This experimental work was carried out in the Agricultural Experimental Station of the Desert Research Center at EL – Sheikh Zuwayid City, about 35 Km East El-Arish city, North Sinai Governorate during, 2008/2009.

Meteorological data for 12 years (1996-2007) were collected to compute ETo rates using Penman–Monteith equation. (TABLE 1) as recommended by the FAO Expert Consultation held in May 1990 in Rome, Italy, using CROPWAT, software version 5.7[19]. In general, the North Eastern part of Sinai Peninsula is dominated by the Mediterranean climate, which is characterized by hot dry summer and relatively cold winter.

TABLE 1 : Meteorological data of average 12 years (1996-2007) for studied area

Elements	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Max. Temp. °C	16.64	17.25	19.68	22.98	26.12	29.37	32.10	32.95	31.80	28.50	23.59	19.00
Min. Temp. °C	9.57	9.94	11.54	13.59	15.69	17.92	19.85	20.29	19.44	17.24	14.02	11.04
Relative humidity (%)	81.49	80.49	79.84	78.17	82.21	84.94	86.41	85.34	81.65	83.17	77.28	80.74
Wind speed (km/day)	209.46	236.06	222.44	201.54	179.16	148.00	162.48	137.80	154.20	167.56	191.24	186.32
Sunshine hours (n)	6.98	7.69	8.25	9.35	10.34	11.80	11.88	11.30	10.30	9.15	7.70	6.67
Rain (mm) *	42.43	32.46	20.07	8.23	0.46	0.44	0.10	0.08	0.19	13.97	13.23	42.73
ETo (mm/day)	1.75	2.22	2.94	3.90	4.55	5.24	5.59	5.36	4.68	3.47	2.58	1.81

***Total rain = 174.39 mm/year** **ETo = Potential evapotranspiration (mm/day)**

The physical and chemical characteristics of the studied soil site are recorded in TABLES (2a & b). The relevant physical and chemical properties of the soil of the experimental site were determined according to Richards[16]. The soils are non saline non alkali, soil texture is sandy and 7.3 % w/w available moisture.

TABLE (2a) : Some physical properties of the soils selected for experimental work

Soil depth (cm)	Particle size distribution (%) Coarse sand	Fine sand	Silt	Clay	Particle density (g/cm^3)	Bulk density (g/cm^3)	Total porosity (%)	Organic matter (%)	Moisture content (%) Field capacity	Wilting point	Available soil water/layer (%)	(mm)	Infiltration rate (cm/hr)	Class
0-50	8.31	84.14	3.22	4.33	2.60	1.45	44.23	0.26	11.25	3.11	8.14	59.02	13.44	Very rapid
-100	8.12	86.18	2.81	2.89	2.57	1.43	44.36	0.24	10.54	3.04	7.50	53.63		
-150	7.84	86.87	2.73	2.56	2.52	1.41	44.05	0.22	9.89	2.94	6.95	49.00		
-200	7.42	87.12	2.65	2.81	2.50	1.40	44.00	0.20	9.55	2.89	6.66	46.62		

TABLE (2b) : Some chemical and physico-chemical properties of the soils selected for experimental work

Soil depth (cm)	$CaCo_3$ (%)	pH (soil paste)	ECe dSm^{-1}	Soluble cations (me/l) Ca^{++}	Mg^{++}	Na^+	K^+	Soluble anions (me/l) $CO_3^=$	HCO_3^-	$SO_4^=$	Cl^-	CEC (me/100g soil)	Exchangeable cations (me/100g soil) Ca^{++}	Mg^{++}	Na^+	K^+
0-50	7.24	7.2	3.55	18.94	8.86	5.23	2.45	0.0	12.84	10.58	12.06	4.59	3.25	0.43	0.61	0.3
-100	6.14	7.4	3.13	17.64	5.66	4.86	3.12	0.0	11.65	10.84	8.79	4.59	3.41	0.39	0.59	0.2
-150	5.74	7.6	3.25	15.43	6.15	5.11	5.85	0.0	10.23	10.34	11.97	4.83	3.50	0.35	0.58	0.4
-200	5.23	7.4	3.15	12.75	7.22	5.42	6.13	0.0	10.84	10.46	10.22	4.78	3.45	0.38	0.65	0.3

The study was conducted in split plot design with three replicates for each treatment were used. The experiments include 36 fig (Soltany) trees cultivated in the experimental site at 6 x 6 m distance, more than 7 years before experimental work, (116 trees/ feddan). The treatments includes: main plots as three irrigation intervals: (I_1= 1 day, I_2= 2 days & I_3= 4 days) with irrigation amounts calculated according to Penman-Monteith equation and sub-main plots as four soil-plant management treatments: (control without additions, black plastic mulch (BPM), spray Abscisic acid (ABA) 10% w/w & combined BPM + ABA). Abscisic acid is sprayed foliarly every 15 days. Growing period was about 273 days from 1$^{st.}$ May to 31$^{th.}$ October 2008 and 1$^{st.}$ February to 30$^{th.}$ April, 2009.

All trees received the recommended doses of organic manure, (10 Kg/tree) and mineral fertilization NPK: 65, 15.5 and 70 unit as: Ammonium sulphate at one rate of 65 unit, (about 300 Kg/fed) were added in two equal doses during March and June with irrigation water by using a fertigation unit in drip system. Calcium superphosphate at a rate of 15.5 units, (about 100 Kg/fed) were added in three equal doses during March, June and September months. Potassium sulphate at the rate of 70 unit, (about 140 Kg/fed) were added in two equal doses alternatively with nitrogen fertilization by using a fertigation unit. Magnesium sulphate (50 Kg/fed.); borax (30 Kg/fed.) and some micro-nutrient elements were added in monthly doses.

Soil moisture was measured with both tensiometer and gravimetric method at depths of 0 -50, - 100 and - 150 cm.

Irrigation with saline ground water about; 2827 ppm was applied by drip irrigation system. The chemical analysis of irrigation water was carried out using the standard methods of Rainwater and Thatcher[14]. The analysis, TABLE 3 revealed that, this water belongs to high salinity, high sodium, i.e., $C_4 S_2$ water; Richards[16].

TABLE 3 : Chemical analysis of the irrigation water of North Sinai research station

P^H	E.C (dS/m)	S.A.R	Soluble cations (meq/l)				Soluble anions (meq/l)				Class
			Ca^{++}	Mg^{++}	Na^+	K^+	$CO_3^=$	HCO_3^-	$SO_4^=$	Cl^-	
7.2	4.4	5.01	11.14	11.23	16.75	5.13	0	12.56	13.84	17.85	$C_4 S_2$

S.A.R = Sodium adsorption ratio & meq.= ml equivalent per liter

The amount of irrigation water (TABLE 4) was calculated using the equation:

$$D_{iw} = ((ETo \times Kc \times D \times Cr \times No.T.)/Ea) + R$$ [3]

Where: D_{iw} = Applied irrigation water (liter/tree/day)
ETo = Potential evapotranspiration (mm / day)
Kc = Crop coefficient .
Cr = Canopy cover represented by the shadow area under trees at mid-day which in average = 7.1 m^2.
No. T. = No. of trees/fed = 116 trees.
Ea = Irrigation system efficiency (%) = 85 % for drip irrigation.
D = Root depth = (2 m).
R = rainfall (mm).

TABLE 4 : Daily irrigation water applied to fig crop (liter/tree/day)

Months	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep,	Oct.	Average
ETo (mm/day)	2.22	2.94	3.90	4.55	5.24	5.59	5.36	4.68	3.47	4.22
G. Period (days)	28	31	30	31	30	31	31	30	31	30
Kc	0.50	0.55	0.60	0.70	0.70	0.60	0.60	0.50	0.50	0.58
Root Depth (m)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
W.R.	18.58	27.05	39.10	53.22	61.29	56.03	53.73	39.06	28.99	41.89
I.R.	5.99	20.02	36.12	53.06	61.13	55.99	53.70	38.99	24.10	38.79

Irrigation requirements (I.R.) = 1237.32 m^3/fed/season = Water requirements 1333.08 (W.R.) – Effective rainfall (Pe)

To determine water consumption, soil moisture content was gravimetrically determined and the crop water consumptive use was then calculated by the following equation:

$$ETa = (M._2\,\% - M._1\,\%) \times d_b \times D \times 1000\ mm$$ [3]

Where : ETa = Actual evapotranspiration, mm.
$M._2$ = Moisture content after irrigation, % .

$M._1$ = Moisture content before irrigation, % .
d_b = Bulk density of soil, g / cm^3
D = Depth, cm.

At the end of the experiment, plants were harvested and yield was recorded. The water use efficiency was calculated by dividing the crop yield / the amount of seasonal evapotranspiration[7]. The water economy was calculated by dividing the crop yield / the amount of water added as kg/m^3[24]. The crop coefficient was calculated by dividing the actual evapotranspiration (ETa) / potential evapotranspiration (ETo)[28]. Beneficiary factor (Bf) was calculated by dividing the actual evapotranspiration (ETa) / the applied irrigation water (Diw), Allen *et al.*[1]. The investment ratio was calculated as (IR) = Output LE / Input LE, (total costs), Rana *et al.*[15].

Owing to the successive ripening of figs, the cultivars were picked twice for the first crop (at the beginning and mid of July) and twice for the second crop (at the beginning and mid of September). At the end of the experiment in October, all trees were harvested and yield was recorded. Data were statistically analyzed using Snedecor and Cochran[20].

RESULTS AND DISCUSSION

Fig fruit yields

Data presented in TABLE 5 show clearly that fruit weight and yield increased with increasing irrigation intervals from 1 day to 4 days. However, the higher magnitude of increase is more evident on increasing irrigation interval from 1 to 2 days but further increase of irrigation interval to 4 days leads to a less pronounced increase of both fruit yield and total yield.

TABLE 5 : Fig fruit yields as affected by water management and some anti-evaporative and anti-transpirant

Irrigation intervals	Treatments	Fruit weight (gram)	Yield (kg/tree)	Yield (ton/fed)
Control (1day)	Control (without)	60.00	4.800	0.557 b
	Abscisic acid	63.00	5.040	0.585 ab
	Plastic mulch	65.40	5.232	0.607 a
	ABA and mulch	67.20	5.376	0.624 a
	Average	63.90	5.112	0.593 a
2 days	Control (without)	69.00	5.520	0.640 b
	Abscisic acid	72.60	5.808	0.674 ab
	Plastic mulch	75.00	6.000	0.696 a
	ABA and mulch	77.40	6.192	0.718 a
	Average	73.50	5.880	0.682 a
4 days	Control (without)	71.40	5.712	0.663 b
	Abscisic acid	74.40	5.952	0.690 ab
	Plastic mulch	78.60	6.288	0.729 a
	ABA and mulch	80.40	6.432	0.746 a
	Average	76.20	6.096	0.707 a

L.S.D. Intervals 0.05 = 0.26* & L.S.D. Applications 0.05 = 0.039*
a, b, letters indicated significant differences between treatments.

As common under prevailed arid environments, drought events may have a large impact on both productivity and crop quality. In this context, occasional or episodic drought events could be counteracted through the use of antitranspirants and anti-evaporative. These compounds are applied to foliage to limit the water loss.

Applications of anti-evaporative (BPM) and anti-transpirant (ABA) either individually or combined have also contributed to increasing both fruit and total yields but the magnitude of increase is more pronounced on combined application of BPM and ABA followed by the individual addition of BPM while ABA corresponds to the least increase of yield over control.

In short, statistical evaluation of data dictates that the increases in fruit weight and yield with increasing irrigation intervals are insignificant while being significant on addition of anti-evaporative and anti-transpirant either individually or combination.

These findings are mainly due to stimulation of concurrent flow of water and heat and partial aeration, which increase fig yield. They may also be explained by the effect of expanding irrigation period on enhancing root elongation, and the role of mulching that accelerates this elongation which, in turn, is reflected on yield of trees. On the other hand, the variations in yield due to alternate bearing are improved as the fruits under shading by black plastic mulch are getting a reduced light penetration. Also, the increase in NPK uptake of fig trees due to applied treatments is expected. Moreover, anti-transpirant foliar addition is able to increase the leaf resistance to water vapor loss thus improving plant water use to assimilate carbon, and, in turn, the production of biomass or yield[25].

Similar results were reported by Allen et al.[1], Plaut et al.[12], Slavin[18] and Solomon et al.[21].

Actual evapotranspiration (ETa)

Actual evapotranspiration is the combination of two processes, evaporation from soil and plant surfaces and transpiration from plant. TABLE 6 gives the monthly actual evapotranspiration values (liter/tree/day) as detected by field measurements throughout the growth season and show that the effect of irrigation intervals on fig water consumptive use was not significant, however the impact of applications on water consumptive use was significant. These findings may be due to increasing evaporation by short irrigation interval which maintains the soil wet much longer thus increasing evapotranspiration by increasing the amount of available soil moisture. However, reducing evaporation by using applications led to stopping evaporation from the mulched surface which changes the rhizosphere toward more water utilization of plants. Another approach to reduce water loss due to transpiration is by increasing the reflection of sunlight from leaves, through reflectant type of antitranspirants, thus limiting the water loss deputed to evaporative leaf cooling[6]. Consequently, ETa increased with increasing the plant growth.

TABLE 6 : Actual evapotranspiration of fig trees as affected by water management and some anti-evaporative and anti-transpirant

Irrigation intervals	Treatments	Feb.	Mar.	Apr.	Ma.	Jun.	Jul.	Aug.	Sep.	Oct.	liter/tree/day	m^3/fed
Control (1day)	Control	14.61	24.54	36.35	49.50	57.38	53.22	50.14	37.65	27.15	38.95	1233.41a
	ABA	13.93	23.89	35.14	47.90	55.62	50.98	48.52	34.99	24.92	37.32	1181.90a
	PM	13.26	22.90	32.79	45.24	52.81	48.74	44.00	31.89	23.14	34.98	1107.62b
	ABA & PM	12.81	21.27	30.88	42.58	51.22	45.94	45.70	30.56	21.20	33.57	1063.19b
Average		13.65	23.15	33.79	46.30	54.26	49.72	47.09	33.77	24.10	36.20	1146.53a
2 days	Control	13.04	21.91	35.29	47.90	55.77	48.74	47.75	35.86	25.86	36.90	1168.62a
	ABA	12.44	21.33	34.12	44.71	53.93	47.62	46.21	33.33	23.74	35.27	1116.88a
	PM	11.84	20.45	31.83	43.11	50.87	45.94	41.91	30.37	22.04	33.15	1049.83b
	ABA & PM	11.44	18.99	29.98	41.51	49.03	44.26	43.52	29.11	20.19	32.00	1013.47b
Average		12.19	20.67	32.81	44.31	52.40	46.64	44.85	32.17	22.96	34.33	1087.20a
4 days	Control	12.08	20.29	32.68	46.27	58.22	53.22	47.28	33.20	23.94	36.35	1151.21a
	ABA	11.52	19.75	31.59	44.52	56.38	50.98	43.64	30.86	21.98	34.58	1095.09a
	PM	10.96	18.94	29.47	43.23	55.16	48.18	40.00	28.12	20.41	32.72	1036.16b
	ABA & PM	10.59	17.58	27.76	41.98	51.48	45.94	38.65	26.95	18.69	31.07	983.91 b
Average		11.29	19.14	30.38	44.00	55.31	49.58	42.39	29.78	21.26	33.68	1066.59a

L.S.D. Intervals 0.05 = 436.14* & L.S.D. Applications 0.05 = 63.19*
a, b, letters indicated significant differences between treatments.

TABLE 6 reveals that consumptive use values were generally low at the beginning of the growing season and gradually increased until the ripening stage then decreased at the harvest stage. The highest increase in consumptive use was associated with the flowering and maturity stages of fig trees. This trend is due to the amount of water available to plants in addition to the higher evaporation from wet rather than dry soil surface In brief, ETa decreased with increasing soil moisture deficit. This may be attributed to the fact that soil was kept wet by little irrigation amounts. Nevertheless, higher seasonal consumptive use is mainly rendered to increasing evaporation rates from the soil matrix.

Statistical evaluation of data, TABLE 6, shows non significant decrease for water consumptive use of fig trees by increasing irrigation intervals and significant decrease by adding applications BPM and ABA. The lowest values of water consumptive use were obtained on irrigation every 4 days < 2 < 1 and applied (combined BPM + ABA) < BPM < ABA < control without additions. Similar results were provided by Allen et al.[1], Tambussi and Bort[25] and Marcello et al.[11].

Water use efficiency (W.U.E.) of fig crop

TABLE 7 reveals that the highest values of water use efficiency of fig were obtained for plants irrigated every 4 days relative to those irrigated every 2 and 1 day, respectively. Applications of anti-evaporative and anti-transpirant treatments lead to decreasing water use efficiency in the order: (combined BPM + ABA) > BPM > ABA > control without additions. These findings may be due rendered to reducing evaporation and consequently evapotranspiration under mulching and decreasing soil moisture content which are reflected on fig yield under these conditions. Statistical evaluation of data postulates non significant increases in water use efficiency by increasing irrigation intervals while significant increases were approached by adding applications BPM and ABA.

TABLE 7 : Water use efficiency, water economy, Beneficiary factor (Bf) and water saving of fig trees as affected by water management and some anti-evaporative and anti-transpirant

Irrigation intervals	Applications	WUE (Kg/m3)	WEco (Kg/m3)	Beneficiary factor (Bf)	Water saving
Control (1day)	Control	0.45 d	0.42 c	0.93 a	0.00
	ABA	0.49 c	0.44 bc	0.89 a	0.04
	PM	0.55 b	0.46 ab	0.83 b	0.09
	ABA & PM	0.59 a	0.47 a	0.80 b	0.13
Average		0.52 a	0.44a	0.86 a	0.07
2 days	Control	0.55 d	0.48 c	0.88 a	0.05
	ABA	0.60 c	0.51 bc	0.84 a	0.09
	PM	0.66 b	0.52 ab	0.79 b	0.14
	ABA & PM	0.71 a	0.54 a	0.76 b	0.16
Average		0.63 a	0.51 a	0.82 a	0.11
4 days	Control	0.58 d	0.50 c	0.86 a	0.06
	ABA	0.63 c	0.52 bc	0.82 a	0.10
	PM	0.70 b	0.55 ab	0.78 b	0.15
	ABA & PM	0.76 a	0.56 a	0.74 b	0.19
Average		0.67 a	0.53 a	0.80 a	0.13

L.S.D. Intervals 0.05 = 0.244*, 0.201, 0.325 & L.S.D. Applications 0.05 = 0.041*, 0.031, 0.045 for WUE, Weco, Bf. Res.
a, b, c, d, letters indicated significant differences between treatments.

Commenting on the obtained results, one should mention that the high soil heat pertaining to treatments, either in temperature or flux, fig suggests the activation of both water and nutrient uptake by roots of fig trees in conjunction with stimulation of concurrent flow of water, heat and partial aeration, which increase the crop yield. These results are in harmony with Allen et al.[1], Tambussi and Bort[25] and Marcello et al.[11].

Water economy (W.Eco.)

Data presented in TABLE 7 reveal that non significant increase in water economy by increasing irrigation intervals and significant increase by adding applications BPM and ABA. The highest values of water economy coincided with irrigation every 4 days and combined application of BPM + ABA.

These findings may be due to the integrated effect of reducing evaporation thus saving the stored soil moisture and also to high yields, thereby high water economy values. The obtained results confirmed the previous findings of Allen et al.[1], Tambussi and Bort[25] and Marcello et al.[11].

Beneficiary factor (Bf)

Beneficiary factor of fig trees increased by increasing intervals between successive irrigation and particular applications (TABLE 7). Data presented in TABLE 7 reveal an insignificant decrease in (Bf) by increasing irrigation intervals and significant decrease by applications of BPM and ABA. The lowest values of beneficiary factor were obtained by irrigation every 4 days and applying (combined BPM + ABA). To suffices, the obtained (Bf) values ranged between 0.74 and 0.93. This finding confirms the success of 4 days interval of irrigation rather than the other two treatments due to low irrigation efficiency. It is worthy to note that the efficiency of drip irrigation was assumed to have 85 %[3], so adopting expanded irrigation intervals with some surface applications are advised to these conditions. Similar findings were stated by Allen et al.[1], Espý´ et al.[4], Tambussi and Bort[25] and Marcello et al.[11].

Water saving

Data presented in TABLE 7 reveal that the highest increase in water saving (13%) corresponds to irrigation every 4 days while being 11% and 7% for irrigation every 2 and 1 day, respectively. Regarding anti-evaporative and anti-transpirant treatments, water saving follows the order: (combined BPM + ABA), (19%) > BPM (15%) > ABA (10%) > control without additions (6%). Accordingly, the highest water saving is reached upon irrigation every 4 days and combined BPM + ABA. This may be interpreted in light of decreasing actual evapotranspiration and decreased crop coefficient (Kc), which could be considered as water saving parameters under suitable environmental conditions. Similar findings were reported by Allen et al.[1], Espý´ et al.[4], Tambussi and Bort[25] and Marcello et al.[11].

Crop coefficient (Kc) of fig crop

The crop coefficient is useful in meeting the irrigation needs of crops and in efficient utilization of the scarcely available and costly water in arid areas. It is also used in computerized irrigation programs. Data in TABLE 8 show non significant decrease in crop coefficient by increasing irrigation intervals and significant decrease by applications of BPM and ABA. The lowest values of crop coefficient were obtained on irrigation every 4 days and applying (combined BPM + ABA).

TABLE 8 : Crop coefficient of fig trees as affected by water management and some anti-evaporative and anti-transpirant

Irrigation intervals	Treatments	Feb.	Mar.	Apr.	Ma.	Jun.	Jul.	Augu.	Sep.	Oct.	Season
Control (1day)	Control	0.46	0.59	0.66	0.77	0.77	0.67	0.66	0.57	0.55	0.63 a
	ABA	0.44	0.57	0.63	0.74	0.75	0.64	0.64	0.53	0.51	0.61 a
	PM	0.42	0.55	0.59	0.70	0.71	0.61	0.58	0.48	0.47	0.57 b
	ABA & PM	0.41	0.51	0.56	0.66	0.69	0.58	0.60	0.46	0.43	0.54 b
Average		0.42	0.54	0.59	0.70	0.72	0.61	0.61	0.49	0.47	0.57 a
2 days	Control	0.41	0.52	0.64	0.74	0.75	0.61	0.63	0.54	0.52	0.60 a
	ABA	0.39	0.51	0.62	0.69	0.72	0.60	0.61	0.50	0.48	0.57 a
	PM	0.37	0.49	0.57	0.67	0.68	0.58	0.55	0.46	0.45	0.54 b
	ABA & PM	0.36	0.45	0.54	0.64	0.66	0.56	0.57	0.44	0.41	0.52 b
Average		0.38	0.48	0.58	0.67	0.69	0.58	0.58	0.47	0.45	0.54 a
4 days	Control	0.38	0.49	0.59	0.72	0.78	0.67	0.62	0.50	0.49	0.58 a
	ABA	0.36	0.47	0.57	0.69	0.76	0.64	0.57	0.46	0.45	0.55 a
	PM	0.35	0.45	0.53	0.67	0.74	0.61	0.53	0.42	0.41	0.52 b
	ABA & PM	0.34	0.42	0.50	0.65	0.69	0.58	0.51	0.41	0.38	0.50 b
Average		0.35	0.45	0.53	0.67	0.73	0.61	0.54	0.43	0.41	0.52 a

L.S.D. Intervals 0.05 = 0.221* & L.S.D. Applications 0.05 = 0.032*
a, b, letters indicated significant differences between treatments.

Adjusting crop coefficient under suitable environmental conditions could be considered as water saving parameter. In this connection, the obtained results may be rendered to the decrease in actual evapotranspiration components, i.e., decreasing evaporation from mulch and transpiration from plants, thus decrease crop coefficient. Similar results were reported by Allen et al.[1], Espý´

et al.[4], Tambussi and Bort[25] and Marcello et al.[11].

Economical assessment

From the applied viewpoints, the economical evaluation of the experimental findings is of a great importance since the net return of treatments is the prime mover of farmers to use, or not. The values of investment ratio (I R) are depicted in TABLE 9.

From the table, it is quite clear that irrigation every 4 days together with using black plastic mulch gave the best values of IR of fig trees. Instead, an antitranspirant, such as CHT that acts on stomatal regulation in an ABA-dependent way can be more effective in temperate regions, when occasional or episodic drought events occur. In any case, it must be considered that CHT, with its low environmental impact and economic cost, is also a resistant inducer against plant viruses[5,8,13], which adds a further value to this compound. The results are in harmony with Iriti et al.[8].

TABLE 9 : Investment ratio of fig crop grown in North Sinai area

items	Field practices	Control (one day)				Two days				Four days			
		Cont	ABA	PM	ABA & PM	Cont	ABA	PM	ABA & PM	Cont	ABA	PM	ABA & PM
List of Inputs, LE/fed	Land preparation, LE/fed	40	40	40	40	40	40	40	40	40	40	40	40
	Cultivation, LE/fed	40	40	40	40	40	40	40	40	40	40	40	40
	Applications, LE/fed	0	75	75	150	0	75	75	150	0	75	75	150
	Irrigation, LE/fed	333	333	333	333	333	333	333	333	333	333	333	333
	Irri. Systems Costs, LE/fed	200	200	200	200	200	200	200	200	200	200	200	200
	Mineral Fertilizer, LE/fed	100	100	100	100	100	100	100	100	100	100	100	100
	Organic Fertilizer, LE/fed	100	100	100	100	100	100	100	100	100	100	100	100
	Fert. Labors Costs, LE/fed	40	40	40	40	40	40	40	40	40	40	40	40
	Pest Control, LE/fed	40	40	40	40	40	40	40	40	40	40	40	40
	Weed Control, LE/fed	40	40	0	0	40	40	0	0	40	40	0	0
	Machines, LE/fed	20	20	20	20	20	20	20	20	20	20	20	20
	Fuel, LE/fed	40	40	40	40	40	40	40	40	40	40	40	40
	Harvesting, LE/fed	40	40	40	40	40	40	40	40	40	40	40	40
	Crop Transport, LE/fed	40	40	40	40	40	40	40	40	40	40	40	40
	Rent, LE/fed	200	200	200	200	200	200	200	200	200	200	200	200
	Total Input, LE/fed	1273	1348	1308	1383	1273	1348	1308	1383	1273	1348	1308	1383
List of Outputs	Fig fruits yield, kg/fed	557	585	607	624	640	674	696	718	663	690	729	746
	Price, LE/kg	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
	Total Price, LE/fed	1114	1169	1214	1247	1281	1347	1392	1437	1325	1381	1459	1492
	Net Income, LE/fed	-160	-179	-94	-136	7	-1	84	53	52	33	151	109
Investment Ratio, LE/ILE		0.87	0.87	0.93	0.90	1.01	1.00	1.06	1.04	1.04	1.02	1.12	1.08

CONCLUSION

From the previous findings, one can conclude that: Irrigation of fig every 4 days and the use black plastic mulch under trees are recommended to get the highest investment ratio at the prevailed conditions in the studied area. Those management practices saved water by about 19 %, thus contribute to water use efficiency and economy.

REFERENCES

[1] R.G.Allen, L.S.Pereira, D.Raes, M.Smith; In: 'Crop evapotranspiration. Guidelines for computing crop water requirements'. Irrig.& Drain.Paper No.56, FAO, Rome, Italy, **(1998)**.

[2] P.Bowen, B.Frey; Hort.Sci. **37**, 95-100 **(2002)**.

[3] J.Doorenbos, W.O.Pruitt; In: 'Crop water requirements'. Irrig.& Drain.Paper No.24, FAO, Rome, Italy, **(1984)**.

[4] E.Espi, A.Salmeron, A.Fontecha, Y.Garcia, A.I.Real; J.Plast.Film Sheet. **22**, 85-102 **(2006)**.
[5] F.Faoro, S.Sant, M.Iriti, D.Maffi, A.Appiano; Chitin Enzymology. 57-62 **(2001)**.
[6] M.S.Gaballah, M.Moursy; Pak.J.Biol.Sci. **7**, 956-62 **(2004)**.
[7] T.Hsiao, P.Steduto, E.Fereres; Irrig.Sci. **25**, 209-31 **(2007)**.
[8] M.Iriti, M.Sironi, S.Gomarasca, A.P.Casazza, C.Soave, F.Faoro; Plant Physiol.Biochem. **44**, 893-900 **(2006)**.
[9] W.J.Lamont; Hort.Tech. **3**, 35-9 **(1993)**.
[10] A.Liakatas, J.A.Clark, J.L.Monteith; Agric.Forest Meteorol. **36**, 227-39 **(1986)**.
[11] Marcello Iriti, Valentina Picchi, Mara Rossoni, Stefano Gomarasca, Nicola Ludwigd, Marco Gargano, Ranco Faoro; Enviro.and Exper.Bot. **(2009)**.
[12] Z.Plaut, Y.Magril, U.Kedem; J.Hort.Sci.Biotech. **79**, 528-32 **(2004)**.
[13] H.Pospieszny, J.G.Atabekov; Plant Sci. **62**, 29-31 **(1989)**.
[14] K.H.Rainwater, L.L.Thatcher; Methods of collection and analysis of water samples, USGS. Water Supply, Paper No. 1954, **(1960)**.
[15] G.Rana, N.Katerji, M.Mastrorilli, C.R.Camp, E.J.Sadler, R.E.Yoder; Evapotranspiration measurement of crops under water stress: Evapotranspiration and irrigation scheduling. Proc.Int.Conf., San Antonio, Texas, U.S.A., November 3-6, 691-6 **(1996)**.
[16] L.A.Richards; Diagnosis and improvement of saline and alkali soils. Agric.Handbook No.60 U.S. Salinity Lab. Washington D.C., U.S.A., **(1954)**.
[17] D.Sivakumar, T.Regnier, B.Demoz, L.Korsten; J.Hort.Sci.Biotech. **80**, 32-8 **(2005)**.
[18] J.L.Slavin; Nutrition Today. **41**, 180-4 **(2006)**.
[19] M.Smith; CROPWAT. A computer program for irrigation planning and management. Irrig.& Drain.Paper, No. 46, FAO, Rome, Italy, **(1992)**.
[20] G.W.Snedecor, W.G.Cochran; Statistical Methods. 7th Ed. Iowa, State Univ.Press, Ames., Iowa, U.S.A., 593 **(1989)**.
[21] A.Solomon, S.Golubowicz, Z.Yablowicz, S.Grossman, M.Bergman, H.E.Gottlieb; J.Agric.and Food Chem. **54**, 7717-23 **(2006)**.
[22] F.Sutherland, D.L.Walters; J.Phytopathol. **149**, 621-4 **(2001)**.
[23] F.Sutherland, D.L.Walters; Eur.J.Plant Pathol. **108**, 385-9 **(2002)**.
[24] M.Talha, M.A.Aziz, E.M.El-Toni; Egypt.J.Soil Sci. **20(2)**, 121 **(1980)**.
[25] E.A.Tambussi, J.Bort; Ann.Appl.Bio. **150**, 307-21 **(2007)**.
[26] D.L.Walters; Ann.Appl.Biol. **120**, 41-6 **(1992)**.
[27] J.C.Wright; Production of polyethylene film. In: Proc.of the 8th Natl.Agric.Plastics Conf.,: 72-9 **(1968)**.
[28] B.Yaron, E.Danfors, Y.Vaadia; Proc.Egypt.Bot.Sci. **(1973)**.