J. Plant Production, Mansoura Univ., Vol. 9 (12): 1003 - 1012, 2018

Effects of Mulching Soil on Water Consumption, Yield, Fruit Quality and Water Use Efficiency of *"Canino" apricot (Prunus armeniaca* L.*)* Cultivar

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ABSTRACT

The present work was conducted at El-Kanater Horticultural Research Station on *Canino* apricot trees during 2016 and 2017 growing seasons to study the effect of different irrigation regimes (irrigation at both 25 and 50 % of available soil moisture depletion) under mulching treatments; (black polyethylene plastic, white plastic and rice straw mulching) on evapotranspiration, water use efficiency, vegetative growth measurements, yield and fruit quality beside economic studies were also done. The most important results can be summarized as follows: Water consumption use (WCU) was increased in the case of frequent irrigation at 25 % of available soil moisture depletion (I_1) value which was found to be 4137.4 and 3206.9 m^3/fed. in both growing seasons, respectively. Regarding mulching treatments, the values of the water consumption use were increased under both no mulching and rice straw mulching compared with either black plastic or white plastic mulching. Also, black plastic, white plastic and rice straw mulching generally led to increase (WUE) by 81.1 %, 55.6 % and 32.2 % over the un-mulched treatment, respectively in both seasons and Kc values as compared to un-mulched treatments. Moreover, all investigated fruiting parameters (fruit set %, tree yield either as kg or as No. of fruits per tree, ton/fed and yield increment % as compared to the control) were significantly increased as a result of using mulching treatments in comparison with the control. It is quite clear that, leaf N, P and K contents were increased by using both black polyethylene plastic and white plastic mulching treatments in most cases as compared with control. Concerning the economic study, data indicated that, all mulching treatments were resulted in the higher values of profit per feddan as compared to the control treatment. Moreover the pest effective treatment in this respect was mulching with black plastic during both seasons of study. In general, it could be concluded that, both mulching treatments either with black polyethylene plastic or white plastic were most effective.

INTRODUCTION

Apricot is one of the few temperate fruit trees not affected by overproduction. Most apricot trees are cultivated in Mediterranean countries, where drought periods are increasingly common, a fact which makes irrigation water the most limiting factor for apricot productivity. Commercial apricot production depends on irrigation. For this reason, in this area the optimization of the use and efficiency of irrigation by means of deficit irrigation strategies that permit maximum yield whilst reducing water application is of a great importance.

Among the water management practices for increasing water use efficiency (WUE) is mulching. Any material spread on the soil surface to protect it from solar radiation or evaporation is called mulch. Different types of materials like wheat straw, rice straw, plastic film, grass, wood, sand etc. are used as mulches. They moderate soil temperature and increase water infiltration during intensive rain (Khurshid *et al.,* 2006).

Surface irrigation method is most widely used all over the world (Mustafa *et al*., 2003). Irrigation is an important for all crops, because it influences on growth and development. Availability of adequate amount of moisture at critical stages of plant growth not only optimizes the metabolic process in plant cells, but also increase the effectiveness of the mineral nutrients applied to the crop. Consequently, any degree of water stress may produce deleterious effects on growth and yield of the crop (Saif *et al*., 2003).

Evaporation from the soil surface may account as much as 50% of the total moisture lost from the soil during the growing season for soybean and corn (Shaw, 1959). In this concern, mulching with plant residues and synthetic materials is a well-established technique for increasing the profitability of many horticultural crops (Gimenez *et al*., 2002).

Such effects are mainly contributed to the capacity of mulch to conserve soil moisture (Vavrina and Roka, 2000). In addition, soil temperature is very critical for biological and chemical processes that control nutrient cycling (Donk Van *et al*., 2004).

William and Lamont (1991) Black plastic is the most popular one because it retards weed growth and warms the soil in the spring. The results showed that the mulch made the harvest earlier in addition to reducing soil water loss.

Moreover, Douglas and Sanders (2001) and Sinkeviciene *et al*., (2009) stated that the advantages of using plastic mulches are: increasing soil temperature from 4 to 5 ºC under black mulch, reducing soil compaction and both evaporation weed problems. Also, it is increasing growth and earlier crops.

Sharma *et al*., (2010) observed that mulching is very beneficial for enhancing moisture and nutrient conservation, resulting in increased productivity and improved soil conditions for cropping system.

The objective of this study are to investigate the effect of different available soil moisture depletion and was to investigate the effect of different mulching types on evapotranspiration, yield, fruit quality, water use efficiency, and net return of *"Canino"* apricot cultivar.

MATERIALS AND METHODS

The present investigation was undertaken during the two successive seasons of 2016 and 2017 at the Experimental Farm, El-Kanater Horticultural Research Station, Kalubeia Governorate Fruitful trees of "Canino" apricot (*Prunus armeniaca* L.) cultivar budded on apricot seedlings rootstock. The selected trees were about 18 years old grown on clay loamy soil and planted at 5 x 5 meters apart.

Soil samples from the experimental site were collected to determine main soil physical and chemical properties. Particle size distribution was conducted using the pipette method according to Klute (1986). Soil moisture constants were determined using the pressure membrane apparatus (Stackman 1966). The experimental soil was clay loamy in texture Table 1 and bulk density as well as water-soil characteristic is shown in Table 2. Meteorological data for the Agricultural Research Station are shown in Table 3.

The experiment included eight treatments as follows:

Main plots (irrigation):

I_1: Irrigation when 25 % of available soil moisture was depleted.

I_2: Irrigation when 50 % of available soil moisture was depleted.

Sub-plots (mulching):

1- Black polyethylene plastic sheet (25micron) used to cover soil surface under the plants.

2- White plastic film mulch.

3- Rice straw mulch 30 cm thick was spread out on the soil surface to cover the soil completely.

4- No soil mulching (control).

All mulch treatments were applied on the 1st week of March on the soil up to the end of the season.

Irrigation started after trees received the winter irrigation on March i.e., starting from bud swelling stage. Irrigation was done when moisture reached the relevant level to determine available soil water retained in the soil. Soil moisture was determined grave metrically on oven dry basis of soil samples taken to a depth of 15 cm. up to 60 cm..

Table 1. Physical properties of the experimental soil.

Parameter	Value
Particle size distribution (%):	
Clay %	32.2
Silt %	34.5
Fine sand %	32.2
Coarse sand %	1.1
Texture class	Clay loamy

Table 2. Some soil - water properties and bulk density

Depth	Field capacity (FC)		Wilting Point (WP)		Available water (AW)		Bulk density (BD) g/cm^3
	% by weight	cm	% by weight	cm	% by weight	Cm	
0-15	38.5	7.22	18	3.38	20.5	3.45	1.25
15-30	37.1	7.18	17.4	3.37	19.7	3.57	1.29
30-45	34.2	6.77	16.3	3.23	17.9	3.51	1.32
45-60	33.4	6.81	16.1	3.28	17.3	3.53	1.36
Total		27.98		13.92		14.06	

FC: moisture at 33 KPa (0.33 bar) moisture tension.
WP: moisture at 1.5 MPa (15 bar) moisture tension.
AW = FC-WP

Table 3. Meteorological data in 2016 and 2017 seasons.

Season	2016						2017					
Month	T. max	T. min	W.S	R.H	S.S	R.F	T. max	T. min	W.S	R.H	S.S	R.F
Feb.	23.70	9.10	3.60	51.00	8.20	19.40	20.40	9.20	3.20	62.60	8.20	5.10
Mar.	26.40	11.30	4.10	43.00	8.60	1.50	24.80	10.40	3.60	51.30	8.60	4.20
Apr.	32.80	14.20	4.20	37.00	9.60	5.60	28.90	12.40	3.90	45.40	9.60	28.20
May	34.30	17.30	4.40	35.00	10.80	1.30	34.50	17.40	3.10	37.10	10.80	9.60
Jun.	39.40	21.20	4.20	32.00	12.00	0.00	38.00	20.30	3.20	36.20	12.00	1.90
Jul.	39.90	17.90	3.90	35.00	11.70	0.00	40.10	22.80	3.00	37.60	11.70	0.00
Aug.	37.80	21.90	4.10	44.00	11.10	0.00	38.60	22.80	2.80	42.60	11.10	0.00
Sep.	35.40	20.20	3.90	47.00	10.30	0.00	36.20	19.80	2.80	45.90	10.30	0.00
Oct.	32.00	17.80	3.80	55.00	9.20	2.20	30.40	16.70	2.60	52.20	9.20	14.40

Where: T. max., T. min.= maximum and minimum temperatures °C; W.S = wind speed (m/ sec); R.H.= relative humidity (%); S.S= actual sun shine (hour); S.R= solar radiation (cal/ cm^2/ day). RF = rainfall (mm / month).*[Data were obtained from the agro meteorological Unit at SWERI, ARC]*

Water consumption use (WCU):

Water consumption use or actual evapotranspiration (ETc) values were calculated for each irrigation treatment using the following formula (Israelson and Hansen, 1962).

$$WCU = \sum_{i=1}^{i=4} \frac{(\theta_2 - \theta_1)}{100} \times Bd \times D$$

Where:

WCU= seasonal water consumption use (cm).
Θ_2= soil moisture content after irrigation (on mass basis, %).
Θ_1= soil moisture content before irrigation (on mass basis, %).
Bd= soil bulk density (g/cm^3).
D= depth of soil layer (15cm each).
i= number of soil layer.

Soil moisture content was gravimetrically determined in soil samples taken from consecutive depths from 15 cm down to 60 cm. Soil samples were collected just before each irrigation 48 hours after irrigation and at harvest time

Calculation of crop coefficient and evapotranspiration:

Reference evapotranspiration (ETo):

Reference evapotranspiration (ETo) was calculated using the meteorological data as cited by Doorenbos and Pruitt, (1977) and Allen *et al.,* (1998) as follows: -

The Penman-Monteith equation for estimating potential evapotranspiration Penman Monteith was applied by using CROP WAT model (Smith 1991).

Water use efficiency (W.U.E.):

The production of apricot fruits by one cubic meter of irrigation water (fruit yield in kg / feddan /m^3 water consumed/feddan), as affected by different treatments was calculated by the following equation (Vites, 1965):

$$W.U.E = \frac{\text{Fruits yield (kg)/feddan}}{\text{Seasonal ET (m}^3\text{/water consumed) /feddan}}$$

*** Vegetative growth measurements**

An influence of different treatments in this study on some vegetative growth parameters were evaluated through determining the average shoot length (cm), number of leaves/ shoot and leaf area (cm^2) using portable leaf area meter [Moedl: YMI-A20110122-1]. Therefore, four main branches in different direction of each replicate were labeled On each selected branch ten newly emerging shoots were tagged. On August all current shoots developed on those branches were used for measuring the abovementioned vegetative growth parameters.

*** Fruiting and yield parameters:**

A- Fruiting parameters.

- Fruit set percentage.

In both seasons the initial numbers of flowers at full bloom stage were recorded per each tree in all treatments then, fruit set percentage was estimated according to the following equation

$$\text{Fruit set (\%)} = \frac{\text{Number of developed fruitlets}}{\text{Total number of flowers at full bloom}} \times 100$$

B- Yield parameters (Kg/tree, No of fruits/tree and ton/feddan):

At harvest time, yield of each tree was separately picked up then counted and weighed in Kgs. Therefore, the yield as Kg/ tree, number of fruits per tree and ton/feddan were estimated.

*** Fruit quality:**

Ten fruits were randomly sampled from each individual tree (replicate) for determining some physical and chemical properties of fruits.

A- Fruit physical properties:

Both the average values of fruit weight (gm) and fruit firmness (Ib/inch^2) was determined using Magness and Taylor (1980) pressure tester with 7/18 inch plinger were the two physical studied characters.

B-Fruit chemical properties:

Fruit juice TSS (%) was determined by using a Carl-Zeiss hand refractometer according to A.O.A.C (2000) and fruit juice total acidity percentage was measured according to Vogel (1968) as well as TSS/acid ratio was estimated by divided TSS (%) over total acidity (%). Furthermore, fruit juice total sugar was calculated calorimetrically according to the method described by Malik and Singh (1980).

*** Leaf nutrient composition:**

On mid-August in the two seasons of study, leaf samples of twenty mature leaves were wiped with distilled water then, oven dried at 70 °C .till constant weight ground and stored in smell begs for the determination of N, P and K using the following procedures.

Total nitrogen: total nitrogen content was determined by the modified micro Kjeldehl method according to Cottenie *et al*., (1982).

Total phosphorus: determination was carried out colorimeterically according to Murphy and Riely (1962).

Total potassium: total K content was determined using the atomic absorption spectrophotomer (3300) according to Jackson and Ulrich (1959).

*** Statistical analysis**

All obtained data during both seasons were statistically analyzed using the analysis of variance method according to Snedecor and Cochran (1990). However means distinguished by method described by Weller and Duncan (1969).

RESULTS AND DISCUSSION

1. Soil-water relations:

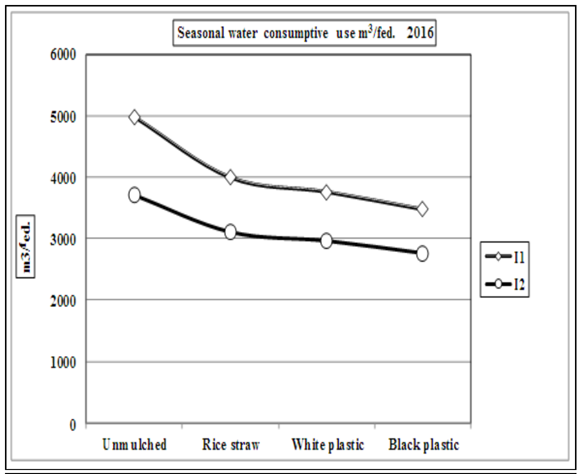
Water consumptive use:

Water consumptive use is the combination of two processes; evaporation and transpiration. Evaporation is the direct vaporization of water from the soil surface and from plant surfaces. Transpiration is the flow of water vapor from the interior of the plant to the atmosphere (Jones *et al*., 1984).

The seasonal changes in the actual evapotranspiration ETa for apricot trees was affected by different mulching treatments during the growing seasons the data of both seasons illustrated in Fig. (1). The main effect of irrigation treatments shows that I_1 gave the highest water consumption use WCU followed by I_2. Mean values were 4137.4 and 3206.9 m^3/fed. in the first season and 4052.7 and 3135.9 m3/fed. in the second one for I_1 and I_2, respectively. Such result might be reasonable, since more frequent irrigation period provide high evaporation opportunity from the relatively wet rather than dry soil surface (Levitt *et al*., 1995 and Devit *et al*., 1994).

The Water consumptive use (i.e. WCU or ETa.) values under soil mulching are lower than the WCU values under un-mulching soil. Black polyethylene plastic mulch treatment recorded the lowest values of WCU followed by white plastic then rice straw mulch treatments as compared to the un-mulched treatments. As it registered 4344.8, 3550.3, 3362.2 and 3120.0 m^3/fed. in the first season and 4427.5, 3595.6, 3439.1 and 3226.5 m^3/fed. in the second one for un-mulched, rice straw, white plastic and black polyethylene plastic mulch treatments, respectively.

These results may be due to the role of mulches in reducing evaporation and keeping soil moisture at root zone to a longer period. In addition, both soil mulching treatments significantly reduced total consumptive use m3/fed, as compared to bare soil in the two seasons of study as shown in Table 3. These results are supported by the observation of Khalifa (1994), El-Henawy (2006) and Mikhael (2007). They mentioned that, monthly and seasonal water consumptive uses of citrus were decreased as affected by different type of mulching.



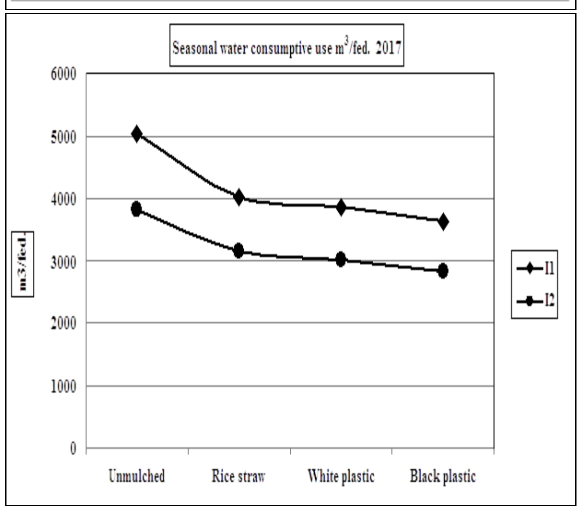


Fig. 1. Seasonal water consumptive use (m^3 /fed.) for apricot trees as affected by soil moisture regimes and different mulching treatments.

Monthly water consumptive use:

Monthly water consumption started low when tree leaves were small and increased gradually with increased tree growth reaching a maximum in July, mainly due to increased demand for water by trees.

Regarding the effect of irrigation and mulching treatments and their interaction on monthly and total water consumptive use CU for apricot trees, the data of both seasons illustrated in Fig. 2 showed that, monthly values of water consumptive use, mm were gradually increased starting from February and reached the maximum values during July, then declined from October. These could be attributed to luxuriant growth of apricot trees in this period. This trend was found to be true under all mulching treatments. The data also show that, monthly values of water consumptive used of apricot trees under soil mulching with black plastic, White plastic and rice straw were the lowest. Meanwhile, the highest values were observed under unmulched one (bare soil). Weagand (1962) pointed out that, the drying rate of bare soil is positively related to the water content and relatively related to lime, and that a drying front advances into the soil linearly. Ibrahim (1981) concluded that the increase in evapotranspiration by maintaining soil moisture at a high level is attributed to excess available water in the root zone.

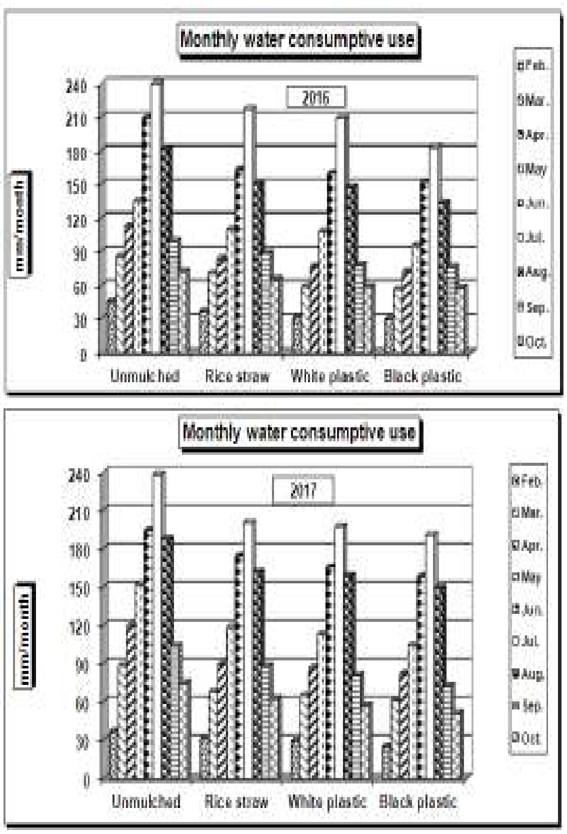


Fig. 2. Monthly water consumptive use mm/month for apricot trees as affected by different mulching treatments during 2016 and 2017 seasons.

Reference evapotranspiration (ETo):

The major parameters required to calculate the ETo are the climatological data, length of growth period of the cultivated crops and surface properties. Data illustrated in Table (4) show that, the values of reference evapotranspiration (ETo) which were calculated according to Penman-Monteith equation reached the maximum in June and July while February and October reflected the minimum value in both 2016 and 2017 seasons. This trend is due to the variation in climate during the two seasons of study.

Table 4. Monthly ETa and ETo mm/month for apricot trees as affected by the different treatments according to the studied equation during 2016 and 2017 seasons.

	ETa mm/ month Actual water consumption use				ETo mm/ month
	First season 2016				
Months	Black plastic	White plastic	Rice straw	Unmulched	Penman-Monteith
February	30	27.5	33.5	45.9	89.3
March	52.5	55.1	66.5	85.7	140.4
April	68.3	73.4	79.6	112.8	183.0
May	91.6	104.32	105.6	135.26	227.2
June	158.6	166.5	169.2	219.3	265.5
July	169.5	195.2	203.8	232.3	261.0
August	130	143.5	146.2	181.9	209.9
September	73	74.7	84.9	100.2	169.5
October	54.2	55.1	61.6	72.5	135.8
Seasonal mm	827.7	895.32	950.87	1185.86	1681.7
	Second season 2017				
February	25.0	25.5	27.5	37	89.3
March	57.4	60.9	64.2	88.6	151.0
April	78.2	82.7	85.9	120	195.0
May	100.5	109.3	114.5	152.3	240.9
June	159.3	166.5	175.5	199.4	267.3
July	176.9	183.4	186.5	228.4	278.1
August	150.4	160	163	192.8	249.6
September	68.5	77.2	84.4	104	207.9
October	47.4	53.4	58.7	74.9	152.2
Seasonal mm	863.9	918.9	960.2	1197.4	1831.2

Crop coefficient (Kc):

The equations were used to assess the extent of closeness of each estimate with the actual values obtained by direct measurement with (I_1) irrigation when 25 % of available soil moisture was depleted. The equation is the Penman-Monteith was applied by using CROP WAT model. The actual crop coefficient (Kc) was calculated for the different types of mulching are shown in Table (5). The maximum un-mulching values (0.93 and 0.86) were obtained in July, while the minimum values (0.51 and 0.41) were obtained in February in both seasons, respectively. The actual (Kc) increased from February to July, then declined in September and October in both seasons. The actual minimum (Kc) values were obtained under black plastic mulch, followed by white plastic then rice straw mulch treatment, while unmulched came in the fourth the rank in this respect. Most crops do not require much water during the season as would be needed to meet the potential evapotranspiration, even though adequate soil moisture can be provided (Jensen, 1968). Thus, the term crop coefficient is used to differentiate water requirements of crops. For the determination of crop coefficient, both actual and potential evapotranspiration are measured concurrently.

Water use efficiency (WUE):

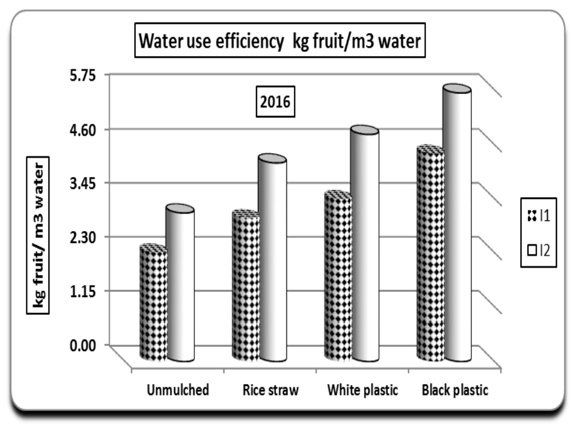
WUE is defined as the ratio of yield to water consumptive use, when applied and stored water does not evaporate, but is used by the crop to produce additional fruit yield as a function of multiple factors, including physiological characteristics of apricot trees, and soil characteristics, meteorological conditions and agronomic practices. Water use efficiencies (WUE) calculated for the different studied treatments are shown in Fig. 3. In general, the values of water use efficiency (WUE) increased with the applying of mulch treatments. The highest increase in (WUE) was obtained under black plastic mulch followed by white plastic then rice straw mulches as compared to un-mulched treatment in both seasons. Average values of (WUE) were (5.05 & 5.07), (4.13 & 4.56), (3.63 & 3.76) and (2.73 & 2.86) kg fruit/m^3 water for black plastic, white plastic, rice straw mulching and un-mulching in both seasons, respectively. This may be due to yield increment under mulching treatments as a result of increasing water availability and decreasing both the weed and water evapotranspiration. Black plastic, white plastic and rice straw mulching generally led to increase (WUE) by 81.1 %, 55.6 % and 32.2. % over the un-mulched treatment, respectively in both seasons. Significant differences in (WUE) among treatments were obtained. These results are in agreement with those obtained by El-Henawy (2006) who reported that, WUE values under soil mulching were higher than under bare soil.

Table 5. Calculated and theoretical crop coefficient (Kc) for apricot trees under mulched and un-mulched conditions during 2016 and 2017seasons.

	First season (2016)				Second season (2017)			
Months	**Unmulched**	**Rice straw**	**White plastic**	**Black plastic**	**Unmulched**	**Rice straw**	**White plastic**	**Black plastic**
February	0.51	0.38	0.31	0.34	0.41	0.31	0.29	0.28
March	0.61	0.47	0.39	0.37	0.59	0.43	0.4	0.38
April	0.62	0.43	0.4	0.37	0.62	0.44	0.42	0.4
May	0.6	0.46	0.46	0.4	0.63	0.48	0.45	0.42
June	0.79	0.6	0.59	0.56	0.73	0.64	0.6	0.58
July	0.93	0.82	0.79	0.69	0.86	0.71	0.7	0.67
August	0.87	0.7	0.68	0.62	0.75	0.63	0.62	0.58
September	0.59	0.5	0.44	0.43	0.5	0.41	0.37	0.33
October	0.53	0.45	0.41	0.4	0.49	0.39	0.35	0.31

2. Some vegetative growth measurements:

Data represented in Table (6) showed the effects of mulching, water irrigation regime and their interaction on some vegetative growth parameters i.e; shoot length (cm), number of leaves per shoot and leaf area (cm^2). Obteined results disclosed clearly that an obvious significantly increased in three grwoth parameters was generaly exhibited with all mulching treatments as compared to the control in the two seasons of study. However, the mulching with black plastic treatment gave the highest significant values in shoot length, number of leaves/shoot and leaf area of apricot trees. (51.8 & 52.1 cm), (35.1 & 35.4) and (53.9 & 54.4) in both 2016 and 2017 seasons, respectively. In the same context the other two mulching treatments (white plastic and rice straw) was significantly in between the abovementioned two extremes in the two seasons of study. Moreover, as the differences between the two levels of irrigation regime were significant whereas, the longest shoot length the highest number of leaves/shoot and the greatest values of leaf area were obtained when appling 25 % (I_1) of available soil mositure wsa deplated as compared to the level of 50% (I_2) of avaliable soil mositure was depleted treatment duringboth first and second seasons of study. On the other hand, regarding the interaction effect between deffrent mulching x irrigation regyme treatments under study, obtained results showed obviously that, (mulching with black plastic x level I_1, 25 %) combination treatment was statistically the superior as had the longest shoots with the highest values for both number of leaves/ shoot and leaf area as compared to the other investigated combination treatments. Meanwhile, the least values of tested grwoth the parameters was always in concomitant to control which was significantly the infirior. In addition, the other combination treatments were statistically intermediate the two extents. Such trend was true during both 2016 and 2017 seasons. Similar observations were also attained by Liu *et al.* (2014) who reported that, the benefits of using mulch in orchards have been reported in many parts of the world to protect plants from extreme transpiration fluctuation and regulation of soil temperature. Moreover, using mulches help in moisture conservation and reduction of evaporation (Sinkeviciene *et al.* 2009), increased soil organic matter (Kiristina *et al.* 2013), and it is considered as a source of plant nutrients (Hostetler *et al.* 2007).



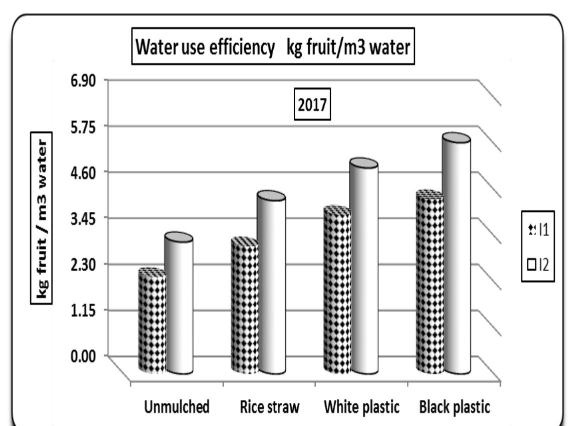


Figure 3. Effect of soil moisture regimes and mulching treatments on water use efficiency (WUE) Kg/m^3 for apricot trees.

Table 6. Effect of water irrigation regime, mulching treatments and their interaction on some vegetative growth of apricot trees during 2016 and 2017 seasons.

Irrigation	Shoot length cm			No. of leaves/shoot			Leaf area (cm^2)		
Mulching	I_1	I_2	Mean	I_1	I_2	Mean	I_1	I_2	Mean
				First season; 2016					
Control	45.47f	42.7g	44.1D	26.9e	25.4f	26.2D	40.8ef	39.4f	40.1D
Rice straw	47.97d	45.6f	46.8C	30.3c	28.3d	29.3C	44.2d	41.8e	42.9C
White plastic	49.70c	47.0e	48.4B	33.4b	30.7c	32.1B	49.8b	47.9c	48.9B
Black plastic	52.37a	51.2b	51.8A	35.0a	35.2a	35.1A	54.6a	53.3a	53.9A
Mean	48.9A	46.6B		31.4A	29.9B		47.4A	45.6B	
				Second season; 2017					
Control	46.3f	44.7g	45.5D	28.6e	26.4f	27.5D	43.3e	41.5f	42.4D
Rice straw	49.0d	47.4e	48.2C	29.4c	27.6d	28.6C	47.8cd	46.2d	47.0C
White plastic	50.3c	48.3b	49.3B	32.8b	31.8bc	32.3B	50.6b	49.2bc	49.9B
Black plastic	52.9a	51.3b	52.1A	35.4a	35.4a	35.4A	55.1a	53.6a	54.4A
Mean	49.6A	47.9B		31.6A	30.3B		49.2A	47.6B	

Means followed with the same letter (s) within each column or row are not significantly different according to Duncan's Multiple Range test at 5 % level.
I_1: irrigation when 25 % of available soil moisture was depleted. I_2: Irrigation when 50 % of available soil moisture was depleted.

2) Some fruiting parameters:

With respect to the effect of some mulching treatments during both 1st and 2nd seasons of study obtained data tabulated in Table (7) displayed clearly that,trees were treated with black plastic, white plastic & rice straw had significantlly the highest values of all fruiting parameters: i.e., fruit set % , yeild as either Kg/tree or ton/fed and number of fruits as compared to the control while, the least significant values of abovmentioned investigated fruiting parameters were statistically exhibited by those untreated apricot trees (control). Moreover, trees treated with black plastic gave the highest significant values in all studied fruting parameters while both mulching tretments (white plastic and rice straw) were in between as compared to the aforesaid two extents. Such trend was detected during both seasons of study.

As for the effect of the two levels of irrigation regames (I_1 and I_2) on some fruiting parameters, data in the same Table indicated that,apricot trees irrigated with the first level (I_1) i.e.,(25%) was sgnificantly superior treatment to improving and icreasing all studied fruiting parametrs (fruit set %, yield kg/tree, yield ton/fed. and yield as No. of fruits) as compared to the second level(I_2, 50%) which had the least valus of abovementioned fruiting parameters during the first and second seasons of study

Regarding the interaction effect of different combination treatments,data revealed that the effect of any studied factor in this investigation was dirctedy reflected on the interaction effect of its own combinatin. Wheres, trees traeted with (black plastic x I_1) combination treatment was the most effective treatment which resulted statistically in the highest values of fruit set % and the heaviest yield either as Kg/tree or ton/fed. and no.of fruits. However, the least values of fruiting parameters were always inconcomitant to that apricot trees tearated with the control. On the other hand, the other combinations treatments was intermediate as compared to the aforesaid two extremes. Such trend was true in the two seasons of study.

Similar observations were also attained by Sajjapongese *et al*., (1989) revealed that yield increased by 67.5% when the crop mulched with black plastic and by 15% when rice straw used as mulch. Sharma *et al*., (2010) observed that, mulching is very beneficial for enhancing moisture and nutrient conservation, resulting in increased productivity and improved soil conditions for cropping system. William and Lamont (1991) black plastic are the most popular one because it retards weed growth and warms the soil in the spring. The results showed that the mulch made the harvest earlier in addition to reducing soil water loss.

Table 7. Effect of water irrigation regime, mulching treatments and their interaction on fruiting and yield parameters of apricot trees during 2016 and 2017 seasons.

Irrigation	Fruiting parameters						Yield parameters					
	Fruit set %			No. of fruits/tree			(Kg / tree)			(Ton/fed.)		
Mulching	I_1	I_2	Mean	I_1	I_2	Mean	I_1	I_2	Mean	I_1	I_2	Mean
							Season; 2016					
Control	8.48d	8.07d	8.28D	2040f	2022 g	2031D	1.79f	68.46g	70.13D	13.13d	11.50d	12.31C
Rice straw	9.27c	8.61d	8.94C	2115d	1986 h	2051C	81.05d	75.07e	78.06C	13.32cd	11.97bd	12.65BC
White plastic	10.23b	9.25c	9.74B	2275c	2070e	2173B	88.63c	80.23d	84.43B	13.48ad	12.32ac	12.90AB
Black plastic	11.69a	9.82bc	10.75A	2403a	2340b	2372A	97.72a	94.90b	96.31A	13.65ab	12.61a	13.13A
Mean	9.92A	8.94B		2208A	2105B		84.80A	79.67B		13.40A	12.10A	
							Season; 2017					
Control	9.80c	8.46e	9.13C	2103f	1995 h	2049D	77.83e	72.57f	75.20D	14.49c	12.25c	13.37B
Rice straw	10.42b	9.07d	9.74B	2210e	2080g	2145C	85.10d	79.33e	82.22C	15.49bc	12.32ac	13.91B
White plastic	10.47b	8.91de	9.69B	2367c	2341 d	2354 B	96.89b	94.80c	95.85B	15.93ab	12.32ab	14.12A
Black plastic	12.10a	10.54b	11.32A	2467a	2419 b	2443A	102.10a	97.70b	99.90A	15.94a	12.25a	14.10A
Mean	10.70A	9.24B		2287A	2208 B		90.48A	86.10B		15.46A	12.29A	

Means followed with the same letter (s) within each column or row are not significantly different according to Duncan's Multiple Range test at 5 % level.
I_1: irrigation when 25 % of available soil moisture was depleted. I_2: Irrigation when 50 % of available soil moisture was depleted.

3. Fruit quality.

- Fruit physical properties:

Concerning the effect of the investigated mulching treatments on both fruit physical characters i.e. fruit weight and fruit firmness, data in Table (8) revealed clearly that both the fruit weight and fruit firmness responded significantly to mulching treatments as compared to the control. Hence the heaviest fruit weight and firmness fruit texture of apricot fruits were statistically in closed relationship to Canino apricot trees mulched by black plastic treatment followed significantly by both (white and rice straw) treatments respectively. Meanwhile, control treatment was statistically the inferior, whereas, it resulted in the lightest fruit weight and softened fruits in both seasons of study. Furthermore, as for the response of both fruit weight and firmness to the two irrigation regime levels (I_1 and I_2), data in the same Table pointed out that, an obvious significantly increase in fruit weight and statistically decrease in fruit flesh firmness were generally exhibited by those treated tree with the first irrigation regime level (I_1, 25%). Such trend was true during both 2016 and 2017 seasons of study. Moreover, data tabulated in same Table displayed obviously that, both combination treatment of the (black plastic x I_1) and (black plastic x I_2) were induced fruits had significantly the highest values of F WT and the firmest flesh texture during the first and second seasons, respectively. However, the control treatment was statistically the inferior as produced fruits had the least values of fruit and the most softened fruits in the two seasons of study. On the other hand, the other combinations were treatments were intermediate as compared to the above-mentioned two extremes. This trend was detected in both seasons of study.

Table 8. Effect of water irrigation regime, mulching treatments and their interaction on fruit Weight (g) and fruit firmness of apricot trees during 2016 and 2017 seasons.

Irrigation / Mulching	Fruit Weight (g)			Fruit firmness (Ib/inch2)		
	I_1	I_2	Mean	I_1	I_2	Mean
			Season; 2016			
Control	33.89f	35.21e	34.55C	9.56g	10.00f	9.78D
Rice straw	37.83d	38.38bc	38.11B	10.29e	10.54d	10.42C
White plastic	38.77b	38.00cd	38.39B	11.34b	11.05c	11.20B
Black plastic	40.55a	40.70a	40.62A	12.27a	12.32a	12.29A
Mean	37.76B	38.07A		10.86B	10.98A	
			Season; 2017			
Control	36.45f	37.01e	36.73C	9.84g	10.17f	10.00D
Rice straw	38.20d	38.50d	38.35B	10.76e	10.90e	10.83C
White plastic	40.54c	40.95b	40.75A	11.64c	11.37d	11.51B
Black plastic	40.40c	41.40a	40.90A	11.92b	12.23a	12.08A
Mean	38.90B	39.47A		11.04B	11.17A	

Means followed with the same letter (s) within each column or row are not significantly different according to Duncan's Multiple Range test at 5 % level.

I_1: irrigation when 25 % of available soil moisture was depleted.

I_2: Irrigation when 50 % of available soil moisture was depleted .

- Fruit chemical characteristics:

Referring the response of some fruit chemical properties (TSS %, acidity, TSS/acid ratio and total sugars) to the effect different mulching treatments under study. Data in Table (9) showed clearly that both TSS% and TSS/acid ratio as well as total sugar were statistically in closed relationship to those apricot trees mulching with black plastic. However, treated trees with black plastic treatment induced significantly the highest values of TSS %, TSS/acid ratio and total sugar followed statistically by both plastic and rice straw treatments, respectively. On the other hand, the control treatment was statistically the inferior as exhibited the lowest values of three studied fruit properties. Such trends were detected during both seasons of study. Contrary to that, the opposite trend was observed with fruit Juice acidity % whereas, both control and rice straw treatments were induced significantly the highest values of acidity %. Meanwhile, both black plastic and white plastic treatments resulted in the lowest significant values of acidity % during 2016 and 2017 seasons of study, respectively. As for the effect of irrigation regimes treatments, data in the same Table indicated that, providing apricot trees with the I_1 (25 %) exhibited fruits had significantly the highest values of TSS %. TSS/acidity ratio and total sugars as compared to the other treatment (I_2). On the other hand, changes in fruit juice acidity % to the effect of irrigation regimes levels treatments were so slight to reach significant and it could be safely neglected in the two seasons of study. With regard to the response of fruit chemical properties of apricot trees to the interaction effect, data in Table (9) indicated that, the effect of each investigated factor (mulching and irrigation regimes) reflected obviously on its own combination and various were significantly quite evident. Anyhow, (mulching with black plastic x I_1 irrigation regimes) combination treatment exhibited statistically the highest values of TSS %, TSS/acidity % and total sugar in the two seasons of study. These results were in the same line with Abd El-Messeih and El-Gendy (2004a) on apricot. From data in both studied seasons it was obvious that, fruits produced from trees grown under dry conditions were significantly higher in the values of juice acidity. The lowest value was obtained from irrigation level (I_1).

4. Leaf mineral contents:

Data in Table (10) showed obviously that, leaf macro element contents i.e.(N, P & K) were significantly increased by using mulching treatments in this study as compared to the control in the two seasons except with leaf P. content which showed insignificantly effect by all used mulching treatments in the first season only. However, the richest leaves in their N, K & P content were exhibited significantly by mulching trees with black plastic in the two seasons of study. Meanwhile the opposite trend was detected with control (untreated trees) treatment which had statistically the poorest leaves in their macro-elements contents (N, P & K) where studied during both 2016 & 2017 seasons of study. Concerning the leave content of (N, P & K) of apricot trees under the two levels of irrigation regimes (I_1 & I_2) data indicated that , the first level (I_1) was superior as exhibited the richest leaves and the highest values for both N & K contents during both seasons of study. Whereas with leaf P content the differences between two levels irrigation regime (I_1 & I_2) were so little to reach level of significance. It could be noticed the absent of significance in the response of P leave content to both levels of irrigation regimes was detected in the two season of study.

These findings were supported by those obtained by Neilsen *et al*. (1986) and Thakur *et al*. (1997) on apple trees and Zeerban (2004) on grapevines they mentioned that, soil mulching treatment increased leaf mineral content under polyethylene mulching. These results may be attributed to the mulching effect on improving root growth and respiration rate due to modifying soil temperature and moisture content, which in turn, created a suitable condition for soil microorganisms. These modification in soil condition may be responsible for increasing nutrients absorption via roots.

Table 9. Effect of water irrigation regime, mulching treatments and their interaction on some fruit chemical properties of apricot trees during 2016 and 2017 seasons

Irrigation	TSS %			Acidity %			TSS/acid ratio			Total sugars		
Mulching	I1	I2	Mean	I1	I2	Mean	I1	I2	Mean	I1	I2	Mean
						Season; 2016						
Control	10.6d	10.0e	10C	0.4a	0.422a-c	0.427A	25.1e	23.2f	24.2C	26.7d	25.3e	26.0C
Rice straw	10.6d	10.4de	10.5C	0.426ab	0.421a-c	0.424A	25.1e	24.4e	24.8C	28.4b	26.7d	27.5B
White plastic	11.7c	11.4c	11.5B	0.403b-d	0.399cd	0.401B	29.3c	28.3d	28.8B	28.6b	27.4c	28.0B
Black plastic	12.7a	12.2b	12.5A	0.386d	0.377d	0.382C	33.8a	31.7b	32.7A	30.1a	29.0b	29.6A
Mean	11.4A	11.0B		0.411A	0.405A		28.3A	26.9B		28.4A	27.1B	
						Season; 2017						
Control	10.9de	10.6e	10.7C	0.424a	0.420a	0.422A	25.9wf	24.9f	25.4C	26.5d	26.1d	26.3C
Rice straw	11.1cd	10.5e	10.8C	0.413a	0.413a	0.413A	26.8e	25.4f	26.1C	28.0bc	27.6c	27.8B
White plastic	12.1b	11.4c	11.8B	0.406ab	0.394bc	0.400B	30.8c	28.1d	29.4B	28.3b	28.0bc	28.2B
Black plastic	12.8a	12.3b	12.6A	0.378cd	0.364d	0.371C	35.3a	32.6b	34.0A	29.7a	29.4a	29.6A
Mean	11.7A	11.2B		0.405A	0.398A		29.7A	27.8B		28.1A	27.8B	

Means followed with the same letter (s) within each column or row are not significantly different according to Duncan's Multiple Range test at 5 % level.
I_1: irrigation when 25 % of available soil moisture was depleted. I_2: Irrigation when 50 % of available soil moisture was depleted .

Table 10. Effect of water irrigation regime and mulching treatments on some leaf macronutrients (N, P and K) contents of apricot trees in 2016 and 2017 seasons.

Irrigation	N (%)			P (%)			K (%)		
Mulching	I_1	I_2	Mean	I_1	I_2	Mean	I_1	I_2	Mean
					Season; 2016				
Control	2.02b	2.07b	2.04BC	0.296a	0.306a	0.301A	2.14de	2.03e	2.09D
Rice straw	2.23ab	2.09b	2.16B	0.309a	0.320a	0.315A	2.31d	2.21de	2.26C
White plastic	2.55a	2.25ab	2.40A	0.323a	0.299a	0.311A	2.94b	2.64c	2.79B
Black plastic	2.48a	2.37ab	2.43A	0.314a	0.324a	0.319A	3.19a	3.11ab	3.15A
Mean	2.64A	2.39B		0.311A	0.312A		2.64A	2.50B	
					Season; 2017				
Control	2.19cd	2.23cd	2.21BC	0.274d	0.278d	0.276C	2.49c	2.15d	2.32C
Rice straw	2.36a-c	2.24d	2.30AB	0.314bc	0.303cd	0.308B	2.82b	2.52c	2.67B
White plastic	2.57ab	2.42b-d	2.50A	0.305cd	0.319bc	0.312B	2.81b	2.37c	2.59B
Black plastic	2.83a	2.70cd	2.77A	0.354a	0.343ab	0.349A	3.22a	3.10a	3.16A
Mean	2.49A	2.40B		0.312A	0.311A		2.84A	2.54B	

Means followed with the same letter (s) within each column or row are not significantly different according to Duncan's Multiple Range test at 5 % level.
I_1: irrigation when 25 % of available soil moisture was depleted. I_2: Irrigation when 50 % of available soil moisture was depleted .

5. Economic study:

The economical comparative study between different treatments shown in Table (11) where calculated at the average of the two studied years. Total cost of production, incomes profits (L.E./fed) and net return (LE/fed.) of apricot trees as affected by available soil moisture depletion and mulching treatments.

Black polyethylene approximately with two seasons of mulching treatment was superior in total income (LE/fed) which in turn increased the net return (LE/fed) (60245 & 48720 LE), respectively comparing with other treatments.

Table 11. Economic analysis as affected by available soil moisture depletion treatment and mulching treatments (average yield and applied water of 2 years).

Irrigation / Mulching		Cost of production					Incomes Profits (L.E. /fed.)			Net return (LE/fed)
		Field practices	Hand hoeing	Mulching	Water cost Irr. (LE)	Total (LE/fed)	Fruit LE/Kg	Kg /fed	Total (LE/fed)	
I_1	Un-mulched	9500	1700	0	2340	13450	5	13810	69050	55510
	Rice straw		1200	1100	1800	13600	5	14405	72025	58425
	White plastic		1400	1150	1710	13760	5	14705	73525	59765
	Black plastic		1400	1150	1680	13730	5	14795	73975	60245
I_2	Un-mulched	9500	1700	0	1980	13380	5	11875	59375	45995
	Rice straw		1200	1100	1680	13480	5	12145	60725	47245
	White plastic		1400	1150	1460	13510	5	12320	61600	48090
	Black plastic		1400	1150	1380	13430	5	12430	62150	48720

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تأثير تغطية التربة علي الاستهلاك المائي والمحصول و جودة الثمار وكفاءة استخدام المياه لأشجار المشمش صنف كانينو

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أجريت الدراسة بالمزرعة البحثية بمحطة بحوث البساتين بالقناطر الخيرية خلال موسمي 2016، 2017 على أشجار المشمش (كانينو) وذلك لدراسة تأثير مستويين من الري (الري عند استنفاذ 25 و 50٪ من الماء الميسر) تحت بعض معاملات تغطية التربة (التغطية بالبلاستيك الأسود- والأبيض- وقش الأرز) على الاستهلاك المائي وكفاءة استخدام المياه وبعض قياسات النمو الخضري و المحصول وجودة الثمار. وكذلك دراسة الجدوى الاقتصادية لتلك المعاملات. - وتتلخص النتائج على النحو التالي: زيادة معدل الاستهلاك المائي عند المستوى الأول (عند استنفاذ 25٪ من الماء الميسر) والتي أعطت معدلات 4137.4 و3206.9 م^3/فدان في كلا الموسمين على التوالي. كما ارتفعت قيم الاستهلاك المائي لمعاملتي الكنترول والتغطية بقش الأرز مقارنة بمعاملتي التغطية بالبلاستيك الأسود والأبيض وذلك في كلا الموسمين، أما فيما يتعلق بكفاءة استخدام المياه فقد ازدادت كفاءة استخدام المياه لجميع معاملات التغطية تحت الدراسة (التغطية بالبلاستيك الأسود- أو الأبيض- أو قش الأرز) بنسب (81.1 % & 55.6 % & 32.2%) على التوالي في كلا الموسمين بينما انخفضت قيم الـ Kc (معامل المحصول) تحت نظام التغطية مقارنة بالكنترول (بدون تغطية)، علاوة على ذلك فقد كانت هناك زيادة معنوية في جميع قياسات الثمار التي تم فحصها(نسبة العقد-إنتاجية الشجرة كجم أو عدد الثمار / الشجرة أو المحصول طن / فدان) وأيضا زيادة في محتوى الأوراق من العناصر الغذائية (N وP وK) في معظم معاملات التغطية مقارنة بالكنترول، وفيما يتعلق بدراسة الجدوى الاقتصادية التي أجريت فقد حققت جميع معاملات التغطية أعلى عائد للفدان مقارنة بالكنترول وكانت أعلاهم معاملة التغطية بالبلاستيك الأسود وذلك في كلا موسمي الدراسة. بشكل عام يمكن أن نستنتج أن جميع معاملات التغطية سواء بالبلاستيك الأبيض أو الأسود أو قش الأرز كانت أكثر المعاملات فعالية.