EFFECT OF SPRINKLER IRRIGATION MANAGEMENT AND STRAW MULCH ON YIELD, WATER CONSUMPTION AND CROP COEFFICIENT OF PEANUT IN SANDY SOIL

ZAYTON, A.M., A.E. GUIRGUIS and KH. A. ALLAM

Agric. Eng. Res. Inst., ARC, Dokki, Giza

(Manuscript received 18 February 2014)

Abstract

Field experiments were conducted at El-Bustan Agricultural Research Station, in summer season of 2013 on peanut (Arachis hypogaea L.) variety Giza 5, to study the effect of sprinkler irrigation management and the application of rice straw mulch on yield, quality, water consumptive use and crop coefficient of peanut in sandy soil. Two irrigation treatments, (I_3) and (I_5) were imposed based on the soil water depletion to bring the soil water deficit to the field capacity at two irrigation intervals of 3 and 5 days. Mulching treatments were applied randomly during the 3-leaf growth stage for one half of the experimental area (M) at a rate of about 500 g/m^2, while the other half remained bare (non-mulched, M_o). The experimental design was split- plot with three replications and consisted of irrigation treatments in the main plots, mulching and non-mulching treatments as subplots. The results revealed that, higher yield and better crop growth were observed in the mulched plots as compared to non-mulched plots under the same irrigation treatments. Also, the effect of I_3 treatment was more pronounced than the effect of I_5 treatments. The average values of maximum plant length, No. of pods/plant, pods weight/plant, total Bio-mass, 100 kernels weight ,total pods yield and total kernels yield, were 65.00 cm, 39.45, 53.20 g., 4012.05 kg/fed, 67.10 g, 1658.80 kg/fed and 1176.00 kg/fed, respectively observed with I_3M treatment. An increase in the tested quality parameters such as shelling percent, protein and oil percentage, of 8.9, 4.40 and 2.13%, respectively were obtained with I_3M treatment as compared to the control treatment (I_3M_O). The computed ET_O value in course of the peanut growth season was 752.25 mm. I_3M_O treatment had the maximum ET_C and applied irrigation water (AIW) values of 2415.0 and 2952.60 m^3/fed, respectively. Applying rice straw mulch conserved irrigation water by about 14.37 and 21.62% with I_3 and I_5 treatments, respectively. WUE ranged from 0.60 with I_3M and I_5M to 0.36 kg/m^3 with I_5M_O treatment, meanwhile, I_5M and I_3M treatments had the maximum IWUE values of 0.48 and 0.47 kg/m^3, respectively. The maximum crop coefficient (K_C) value of 0.88 occurred during July, which was less than the generic value listed in FAO-33and-56 by about 16.2 and 10.2%, respectively, however the average K_C values of peanut at El-Bustan area of 0.73 was close to FAO-33 and-56 listed values. These results showed that precise management of the available soil moisture content in the course of the growing season, and accurate estimation of ET_C as well as, developing site and cultivar specific K_C value can be effective way for appropriate irrigation scheduling and water allocation, saving water, maximizing yield and consequently optimizing the economic return.

Keywords: Peanut, Sprinkler Irrigation, Mulch, Irrigation Management, Crop coefficient.

INTRODUCTION

Field management practices are the most influenced factors affecting crop yield particularly in irrigated agriculture in arid and semi-arid regions. The productivity of sandy soils are limited by higher infiltration rate, high evaporation, low fertility level, low water holding capacity and low organic matter content .Peanut (Arachis hypogaea L.) is considered one of the most important edible oil crops grown in Egypt. The main growing areas concentrated in the north of the country representing newly reclaimed desert areas, and in the east and west of the Nile delta. It is either grown for its nut, oil and its green leafy hay for feeding livestock. Peanut seeds are characterized by their high oil content (about 50%), which is utilized in different industries, besides they contain about 26-28% protein, about 20% carbohydrates and about 5% fiber and ashes. There are some critical points characterized peanut growth stages, flowering and pod filling growth stages are very sensitive to soil water availability compared with early and vegetative and late maturity growth stages. Also, soil temperature, lower than 18^{o}C reduces germination and crop growth and temperature higher than 37^{o}C during pod development restricts pod and kernel growth resulting in lower pod yield (Reddy *et al.*, 2003). Raskar and Bhoi (2003) reported that the practice of mulching is widely used as a management tool in many parts of the world. It dampens the influence of environmental factors on soil by increasing soil temperature controlling diurnal/seasonal fluctuations in soil temperature. Plastic or straw mulch may efficiently improve the microclimate and growth conditions by promoting plant transpiration at the expense of evaporation from the soil. Ghosh *et al.*, (2006) reported that straw mulch (wheat or paddy) produced more pod and haulm yields of peanut than polythene mulch (black or transparent) and no mulch treatment because of favorable soil water and soil temperature, earlier seedling emergences, more flower and mature pods numbers, lower bulk density and less weeds. Crop yield and water use efficiency (WUE) have been reported to be increased by mulching treatments. Irrigation management is necessary for field crops. Increases water use efficiency (WUE) of field crops is possible through proper irrigation scheduling and water management avoiding any soil moisture stress and critical growth stages. Improper irrigation management not only causes variation in crop yield but also wastes scarce and valuable water resources. Delayed irrigation, particularly when the crop is sensitive to water stress, could affect yield, which cannot compensated for by subsequent over–watering. Sprinkler irrigation offers advantage by light and frequent water application, sufficient to wet the top 0.6m of peanut field in light –textural soil, while furrow irrigation is frequently used on medium textural

soils. Sprinkler irrigation systems with low irrigation frequencies increases yield and water use efficiency due to decreasing water losses during the irrigation season. Timing of irrigation should conform to soil water depletion requirements of the crop which are shown to vary considerably with evaporative demand, rooting depth and soil type as well as with stages of crop growth. Irrigation timing affects peanut pod yield mainly by influencing the duration of pod production (Plaut and Ben-Hur, 2005). Doorenbos and Kassam (1986) reported that the crop coefficient values for peanut crop were 0.45, 0.75, 1.05, 0.8 and 0.55 for initial, development, mid- season, late-season and at harvest stage, respectively. Allen *et al*. (1998) mentioned that the crop coefficient values for peanut crop were 0.50, 0.80, 0.98, 0.8 and 0.55 for the same growth stages, respectively. Rao *et al*. (1985) stated that the greatest reduction in kernel yield of peanut occurred when water stress was imposed during the seed filling growth stage. Also, many researchers mentioned that water stress during the flowering and pegging stages produced the greatest reductions in pod yield followed by water stress at the early–and late - pod stages. Attia and Hammad (1999) stated that maximum peanut pod yield was 1378.7 kg/fed with newly reclaimed sandy soils under drip irrigation system. While, seasonal amount of applied irrigation water and seasonal water consumptive use were 2835 and 2261.7 m^3/fed., respectively. Mohsen, (2001) studied the effects of irrigation intervals, quantities of irrigation water and fertilization methods on peanut productions. Obtained results showed that, the effect of irrigation interval was highly significant on peanut yield, while the effects of irrigation quantities and fertilization methods were not significant. Abdrabbo (2009) stated that the average seasonal actual K_C value of peanut (0.78) is approximately close to the FAO-56 K_C (0.66) and FAO-33 K_C (0.70) Values. Also, the irrigation amount of peanut averaged 587 mm and ranged from 545 to 640 mm. Kamal *et al*. (2010) investigated that, the response of peanut crop to non-uniformity of irrigation application under sprinkler irrigation in sandy soil. They reported that the peanut yield was significantly affected by both irrigation amount and non- uniformity caused by sprinkler layouts and water overlapping. Genetic K_C values for a number of crops grown under different climatic conditions were listed in FAO-33 and FAO-56, indicating only the climate, cropping season and yield, without considering the cultivar and site specifications under given climate conditions. Therefore estimating site and cultivar specific K_C value under given climate conditions is essential for improving irrigation management. Also, calibration of local or regional of FAO–K_C curve is strongly recommended for achieving the accuracy of irrigation scheduling and water allocation. The specific objectives of this research were as folloos:

1- Identifying suitable irrigation scheduling strategy and agricultural practices for reducing crop water use and enhancing productivity and quality of peanut crop.
2- Assessment the impact of different irrigation regimes and mulching treatments on water consumptive use and water use efficiencies.
3- Developing and comparing site- and cultivar-specific peanut crop coefficients with the values listed in FAO- 33 K_C (0.07) and FAO K_C (0.66) 56.

MATERIALS AND METHODS

Experimental site:

Field experiments were carried out during the summer season of 2013 at El-Bustan Agricultural Research Station, Behera Governorate, Egypt. Peanut (Arachis hypogaea L.) variety Giza 5 was planted to study the effect of different sprinkler irrigation regimes and rice straw mulch treatments on yield, water consumptive use and, water use efficiency and to identify the peanut crop factor under site conditions. Soil samples were collected at 20 cm increments to a depth of 60 cm to determine some physical and chemical properties. Obtained results are presented in Table (1).

Table 1. Some physical and chemical properties of the experimental site.

Soil depth (cm)	Mechanical analysis (%)			Texture class	FC (%)	WP (%)	ASM (%)	B.D g./cm^3	pH 1/2.5	EC dS/m
	Sand	Silt	Clay							
0-20	93.2	4.2	2.6	Sandy	10.6	6.1	4.5	1.52	8.25	1.27
20-40	93.1	4.1	2.8	Sandy	10.9	5.8	5.1	1.55	8.3	1.25
40-60	93.0	4.3	2.7	Sandy	10.8	5.2	5.6	1.58	8.3	1.26

Crop management:

Peanut seeds Varity Giza 5 at a rate of 50 kg/fed. were sown on 23 May in rows 50 m length, 0.6m width and about 0.2 m spacing between plants within rows. The experiments were terminated on 25 September 2013. All agricultural practices for peanut production as well as chemical fertilizer quantity were followed as recommended for peanut production at the experimental site. Water application of 25 mm was applied over the entire field area after planting to enhance germination and ensure uniform growth. Irrigation management strategies were initiated at the second irrigation. An additional light irrigation of about 20 mm was applied to the entire field shortly before uprooting to improve the soil turn over and to minimize pods loss. Plants were manually uprooted and trashed with a hand trash after air drying of about 3 days. Samples were taken to determine some productivity parameters, pods, straw yields, oil and protein percentage of seeds.

Irrigation system and Treatments:

Sprinkler irrigation system was used in this experiment. It consisted of control head unit, which located at the source of water supply, centrifugal pump with flow rate of 60 m^3/h at operating pressure of 400 kPa, sand media filter of 100 mesh followed by screen filter of 120 mesh, pressure gauges, pressure regulator, control valves fertilizer tank and flow meter. The control head unit was connected to the main line with110 mm in diameter PVC, sub-main line of 90 mm PVC and sprinkler line of 75/63 mm PVC. Sprinklers with spacing of 12×12 m with two nozzles of 2 and 2.8 mm in diameter were used. The sprinkler discharge and operating pressure were 1.20 m^3/h and 223 kPa. Steel risers of 26.7 mm in diameter were used .The riser length was 1.20 m in length (40 cm buried under ground and 80 cm above the soil surface). Irrigation water was obtained from El-Nasar open channel irrigation system in the experimental area and classified by pH value of 7.8 with average electrical conductivity of 1.12 dS/m. Two irrigation treatments, (I_3) and (I_5) were imposed based on the soil water depletion to bring the soil water deficit to the field capacity at two irrigation intervals of 3 and 5 days, respectively. Mulching treatments were applied randomly to one half of the experimental area (M), while the other half remained bare (non-mulched, M_o), the mulch was a flat rice straw mulch (inexpensive organic residue, locally available, insulate well and conserve moisture) approximately 3.5 to 4 cm thickness (about 500 g/m^2) which covered the entire soil surface. Mulching over 5 cm thickness was avoided to overcome mulching problems (Khalifa *et al.*, 2011). Rice straw mulch was applied at about 3-leaf growth stage. The experimental design was a split plot with three replications. Two irrigation regimes and two mulching treatments were evaluated. Main plots were assigned to two irrigation treatments (I_3) and (I_5). The subplots were assigned to mulching treatments (M, M_o), which were randomly distributed. The treatment of I_3M_O represented the control treatment. The experimental area of about three fed. was divided into two plots, each was 70 m long and 90m width. Each plot was divided into 6 subplots, each was 60m long and 12 m in width (720m^2). A buffer zone of 10m separated between treatments and 3m separated between replicates to avoid interference.

Soil water content and evapotranspiration measurements (ET_C):

The soil water content was measured using the gravimetric soil samples. Measurements were regularly made at 0.20 m increments to a depth of 0.60 m before and after each irrigation event in the course of the season. Applied irrigation water was determined before each irrigation according to water consumed during irrigation intervals measured as the difference between soil moisture content at field capacity and the moisture content before next irrigation plus 15% as leaching requirement and

considering the efficiency of the irrigation system. The depth of water to be applied to bring the soil water deficit to the field capacity and water consumptive use were calculated according to **Hansen *et al*. (1979)** as follow:

$$D_{aiw} = \sum_{i=1}^{i=3} \frac{FC - \theta 1}{100} R_i \times \rho_{si}$$

$$ET_c = \sum_{i=1}^{i=3} \frac{\theta 2 - \theta 1}{100} R_i \times \rho_{si}$$

W*here*:

D_{aiw} = depth of irrigation water to be applied, mm

ET_c = water consumptive use, mm

I= number of soil layers,

FC: soil moisture content at field capacity, %,

$\theta 1$ = soil moisture content before next irrigation, %,

$\theta 2$ = soil moisture content after irrigation, %

R_i = is the soil layer thikness, mm and

ρ_{si} = is the specific density of the soil layer

The depth of irrigation water applied in each irrigation event (I_{rd}) was calculated as:

$$I_{rd} = \frac{D_{aiw}}{\tau \times (1 - LR)}$$

Where:

τ = irrigation effeciency (%), and

LR = Leaching requirment.

Determination of crop coefficient K_c:

Crop coefficient (K_c) is defined by the ratio of the crop evapotranspiration to the reference evapotranspiration as:

$$Kc = \frac{ET_c}{ET_o}$$

Crop coefficient (K_c) was calculated from the estimated ET_C of the peanut crop under optimal growth conditions. The potential evapotranspiration (ET_O) was calculated on a daily basis (mm/day) using CROPWAT model based on penman-Monteith's formula as mentioned by Allen *et al*. (1998). Necessary metrological data used for these calculations are provided by the Central Laboratory for Agricultural Climate (CALC) of Egypt. The values of K_C were compared to the K_C values listed in FAO- 33 and- 56.

Water use Efficiencies:

Water use efficiency (WUE, kg/m^3) and irrigation water use efficiency (IWUE, kg/m^3) were calculated as follows:

$$WUE = \frac{Y}{ET_C}$$

$$IWUE = \frac{Y}{AIW}$$

Where:

Y is the kernels yield (kg/fed.), ET_C and AIW are the seasonal crop evapotranspiration and the seasonal applied irrigation water (m^3/fed.), respectively.

Plant data recorded:

At harvest, random plants samples on 1 m section of the seven central rows (4.20 m^2) in each experimental plot were taken to determine:

a- Plant length (cm).

b- Number of pod and pod's weight/ plant (g).

c- Weight of 100 kernels (g), and total kernels yield (kg/fed.).

d- Pod and straw yield (kg/fed.).

e- Seeds oil and protein percentage based on the procedure of (AOAC), 1975.

Statistical analysis:

Statistical analysis of the collected data were subjected to the statistical analysis of variance (ANOVA). The statistical Package (CoHort, 1986) was used for data analysis. The probability level for determination of significance was 0.05.

RESULTS AND DISCUSSION

A: plant length (PL), cm:

The data concerning the plant length of peanut are presented in Table (2). The statistical analysis of the obtained data showed highly significant effect of both treatments on the plant length. PL increased by about 10% under (M) treatment than (M_O) treatment, meanwhile, 7.1% increase in PL was obtained when the plant was irrigated every 3 days (I_3) compared to I_5 treatments. A significant interaction of the treatments on PL was recorded. The maximum PL of 65.00 cm was obtained with I_3M treatment while, the I_5Mo treatment has the minimum PL of 54.20 cm. These results emphasis that adequate soil moisture content in course of growing season enhanced the development of plant length.

B: Number of pod /plant (PN/p):

Results of the average number of pod per plant (PN/p) are given in Table (2). Obtained results showed highly significant influence of treatments on PN. The average

values of maximum PN/p were 37.95 and 37.26 with I_3 and M treatments, respectively. Highly significant interaction effect of treatments on PN was noticed. I_3M treatment had the maximum PN/p of 39.45 followed by the control treatment (I_3M_O) and I_5M treatments. I_5M_o treatment had the minimum PN/p value of 30.10, about 17.33% less than the control treatment. These results declared that the effect of irrigation interval on PN/p was more pronounced than the effect of mulching treatments. Irrigation every three days offer the best medium for plant growth as compared to irrigation every five days. These results agree with Mohsen, (2001).

C: Pod weight per plant (Pw/p), g:

Pod weight per plant (Pw/P) was investigated, and the results were presented in Table (2).The results showed highly significant effect of treatments on Pw/p. Applying irrigation every 5 days resulted in reducing the Pw/p by about 10.9%. On the other hand, adding a thin layer of rice straw mulch to the soil surface led to an increase in the Pw/p about 13.77%. The interaction effect of different irrigation regimes and mulching treatments on the Pw/p was not noticed. I_3M treatment had the maximum Pw/p of 53.20 g followed by I_5M, I_3M_o and I_5M_o, respectively.

D: Bio-mass yield (Kg/fed.):

Some growth and productivity parameters of peanut were illustrated in Table (2) which, reflect highly significant effect of M treatments on Bio- mass yield. Applying rice straw mulch lead to an increase in the Bio- mass yield about 28.90% as compared to M_O treatments. On the other hand, irrigation every 5 days (I_5), lead to a decrease in the bio- mass yield by about 12.3%. A significant interaction effect of irrigation and mulching treatments on Bio-mass yield was observed, I_3M and I_5M treatments had the highest Bio-mass yield of 4012.05 and 3577.0 Kg/fed, respectively. While, minimum Bio-mass yield (2704.0 kg/fed) was obtained with I_5Mo treatment. These results confirmed that application of rice straw mulch, and irrigation every 3 days offered the adequate soil moisture content in course of the growing season and consequently enhanced the vegetative growth of peanut plant. These results agreed with Attia and Hammad, 1999 and Mohsen, 2001.

Table 2. Some growth and productivity parameters of peanut as affected by different irrigation regimes and mulching treatments.

Treatments		Growth and productivity parameters of peanut				
		Plant length (cm)	No. of pod/plant	Pod weight/plant (g)	T. Bio-mass (kg/fed.)	100 kernel weight (g)
I_3		61.90a	37.95a	49.90a	3634.55a	62.70a
I_5		57.80b	32.56b	45.00b	3188.01b	60.60b
Significance L.		**	***	**	*	*
M		62.70a	37.26a	50.40a	3842.04a	67.00a
M_o		57.00b	33.25b	44.30b	2980.53b	56.50b
Significance L.		***	***	***	***	***
I_3	M	65.00	39.45	53.20	4012.05	67.10
	M_o	59.20	36.41	46.50	3223.73	58.40
I_5	M	61.70	35.10	47.60	3572.02	66.80
	M_o	54.20	30.10	42.20	2704.00	54.60
Significance L.		*	***	ns	*	***

Means within each column followed by the same letter/s are insignificant at 0.05 level of probability, *: significance at the 0.05 probability level,**: significance at the 0.01 probability level and ***: significance at the 0.001 probability level.

E: Average weight of 100 kernels (g):

Results of the average weight of 100 kernels are given in Table (2). Data obtained pointed out a highly significant effect of treatments on the kernels weight. Also, results demonstrated highly effect of mulching treatment on the kernels weight than the irrigation treatments. An increase of 18.60% in 100 kernels weight occurred with M treatment as compared with M_O treatments. Concerning the irrigation intervals, I_5 treatments led to a decrease in the 100 kernels weight by about 3.35% as compared to I_3 treatments. A significant interaction among the treatments was noticed. I_3M treatment resulted in the highest average weight of 100 kernels of 67.0 g, while the lowest average weights of 100 kernels of 58.40 and 54.60 g were obtained with I_3M_O and I_5M_O treatments, respectively. These results indicated that I_3 and M treatments offer adequate soil moisture content that is sufficient to prevent water stress during flowering and pod filling growth stages and enhancing the availability of nutrients located in deeper layers and consequently enhancing the pods and kernels growth. These results agree with Plaut and Ben-Hur (2005).

F-Total pods yield (kg/fed.):

Total pods yield under different treatments are presented in Table (3). The statistical analysis showed that the pods yield was significantly affected by treatments. Applying water irrigation every 5 days (I_5) led to reduce the total pods yield by about 13.27%, while applying rice straw mulch enhanced the total pods yield by about 14.57%. A significant interaction of the treatments on the total pods yield was noticed. I_3M treatment resulted in the highest value of total pods yield of 1658.80 kg/fed, while I_5M_O treatment resulted in the lowest value of total pods yield of 1236.91kg/fed. There were a slight difference in the total pods yield between the control (I_3M_O) and I_5M treatments. The increase in pods yield under I_3 and M treatments compared to other treatments can be explained by the significant increase in pod numbers and weight per plant under the same treatments.

G-Total kernels yield (kg/fed.):

Results of the total kernels yield had the same trend of the total pods yield. These results reflect highly significant effect of the M and I_3 treatments on the kernels yield as shown in Table (3). Also, highly significant interaction among the treatments was noted. The highest values of kernels yield of 1176.00, 1036.50 and 1108.25 kg/fed. were obtained under I_3M, I_3Mo and I_5M treatments, respectively. These results reflected an important factor that if the irrigation water is not available every three days, it can be irrigated every five days simultaneously with applying rice straw mulch with an increase of kernels yield by about 6.96% as compared to the control treatment. On the other hand, I_5M_o treatment had the minimum kernels yield of 802.50 Kg/fed with a reduction of 22.60% as compared to the control treatments.

H-Shelling (%):

The shelling percentage was significantly affected by mulching treatments, meanwhile no significant effect of irrigation treatments was noted as presented in Table (3). Also, there was non- significant interaction effect among the treatments on the shelling percentage. The highest values of shelling percentage of 70.90 and 70.0% were obtained with I_3M and I_5M treatments, respectively. These results are in harmony with those of number of pod per plant, pod weight per plant and 100 kernels weight.

I-Protein and oil percentage (%):

The highest values of protein and oil percentages were obtained under I_3 and M treatments as shown in Table (3). Applying water irrigation every five days resulted in reducing the protein and oil percentages, while application of rice straw mulch enhanced these percentages. Non-significant interaction effect of the treatments on the protein and oil percentage was noticed.I_3M treatment had the highest protein and

oil percentage of 21.61 and 50.83 %, respectively, while I_5M_O treatment had the lowest protein and oil content of 19.62 and 48.57%, respectively.

Table 3.Yield and some quality parameters of peanut as affected by different irrigation regimes and mulching treatments.

Treatments		Growth and productivity parameters of peanut				
		T. pod yield (kg/fed.)	T.kernel yield (kg/fed.)	Shelling (%)	Protein (%)	Oil (%)
I_3		1625.40a	1105.25a	66.6a	21.40a	50.30a
I_5		1409.66b	954.00b	66.40a	20.72b	48.93b
Significance L.		***	**	ns	**	**
M		1620.60a	1142.12a	66.75a	21.53a	50.07a
M_o		1414.46b	918.00b	64.55b	20.60b	49.17b
Significance L.		***	***	**	***	**
I_3	M	1658.80	1176.00	70.90	21.61	50.83
	M_o	1592.00	1036.50	65.10	20.70	49.77
I_5	M	1582.41	1108.26	70.00	21.10	49.39
	M_o	1236.91	802.50	64.88	19.62	48.57
Significance L.		***	***	ns	ns	ns

Means within each column followed by the same letter/s are insignificant at 0.05 level of probability,*: significance at the 0.05 probability level,**: significance at the 0.01 probability level and ***: significance at the 0.001 probability level.

Potential evapotranspiration (ET_O):

Potential evapotranspiration values were calculated based on the agro metrological data collected for the studing area, using the CROPWT model. Table (4) shows values of ET_O through the growth stages of peanut. ET_O values fluctuated due to the change in weather conditions as shown in Fig, (1).The average values of daily ET_O during the peanut growing season was 6.02mm/day. ET_O values increased to 7.15 mm/day in July when most of weather elements increased. The seasonal ET_O value during the growing season of peanut was 752.25 mm.

Evapotranspiration of peanut (ET_C):

ET_C values were estimated in the course of the growing season for different treatments and illustrated in Table (5). The seasonal ET_C values varied due to the change in the environmental conditions, plant growth development and treatments. It is clear that ET_C values increased as the plant age progressed till the mid- season growth stage, then the rate was decreased till the end of the growing season. Also, it

was noticed that ET_C values increased with higher frequent irrigations (three days) due to increasing the soil water depletion, meanwhile, ET_C values decreased with M treatments as compared to M_O treatments. It could be due to the reduction of incoming solar energy, resulted in less evaporated water from the mulched plots compared to the non-mulched plots for all irrigation treatments. Applying mulch reduced the soil moisture depletion by about 81 - 107 mm. Maximum ET_C value (2415 m^3/fed) was occurred with I_3M_O, while, minimum ET_C value (1860.6 m^3/fed) was occurred with I_5M. Reduction of ET_C due to mulching was reported for many other crops (Gouranga and Ashwani, 2007).

Table 4. ET_O values through the different growth stages of peanut.

Growth stages	Initial	Development	Mid-season	Late- season	Total
Duration (days)	25	45	35	20	125
Avg. mm/day	5.66	6.49	6.1	5.26	6.02
mm/stage	141.50	292.05	213.5	105.2	752.25

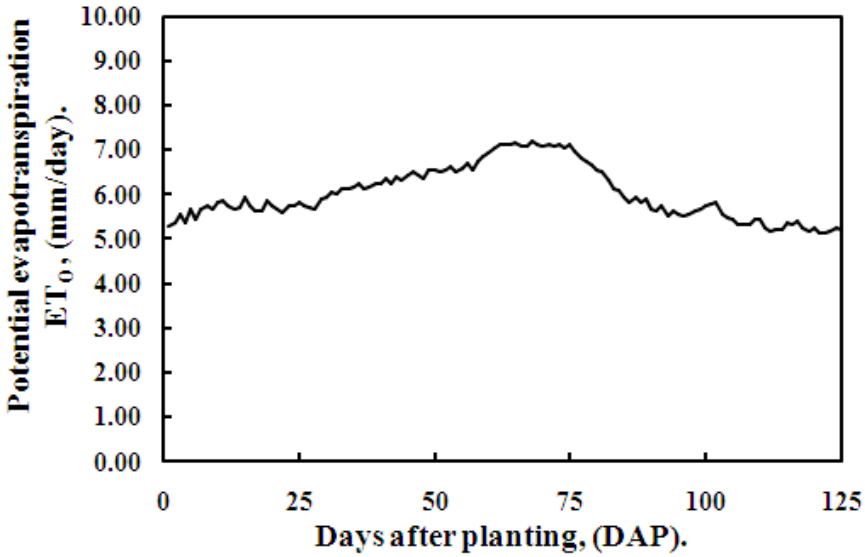

Fig. 1. Potential evapotranspiration in the course of the growing season of peanut during the summer season of 2013.

Applied Irrigation water to peanut (AIW):

The total amount of water applied, i.e., the sum of the preliminary application, the brief pre-harvest irrigation, and the sprinkler irrigation events, are presented in Table (5). The lower the irrigation frequency (five days), the smaller the total amount of water applied, because higher evaporation rates are expected with more frequent irrigations (three days), and probably contributed to higher soil deficits. The control treatment (I_3M_O) had the highest AIW value of 2952.6 m^3/fed, while, I_5M treatment

had the lowest AIW value of 2314.2m^3/fed. Applying rice straw mulch saved about 14.37 and 21.62% irrigation water with I_3M and I_5M treatments, respectively as compared to the control treatment.

Table 5. ET_C values and AIW through the different growth stages of peanut.

Growth stages			Initial	Development	Mid-season	Late-season	Total	
Duration (days)			25	45	35	20	(mm)	(m^3/fed.)
ET_C (mm)	I_3	M	52	192	162	62	468	1965.6
		M_o	85	221	187	82	575	2415
	I_5	M	58	173	155	57	443	1860.6
		M_o	75	216	165	68	524	2200.8
AIW* (mm)	I_3	M	82	218	172	85	602	2528.4
		M_o	128	235	201	94	703	2952.6
	I_5	M	72	195	163	76	551	2314.2
		M_o	123	226	193	86	673	2826.6

*The total amount of water applied included the sum of the preliminary application, the brief preharvest irrigation, and the sprinkler irrigation events.

Developing crop coefficient (K_C):

Site- and cultivar- specific K_C of peanut (Cv. Giza 5) cultivated in sandy soil under El-Bustan region conditions during each growth stage, was developed .Fig (2) and Table (6) illustrate the average calculated crop coefficient of peanut under different treatments. K_C values differ from the average values of FAO -33 and FAO -56, as shown in Fig (2) during the initial and mid-season stages. These differences may be attributed to the specific cultivar and the changes in the environmental conditions. On comparison among K_C values developed by the control treatment (I_3M_O) and FAO-33and FAO - 56, the maximum value of actual K_C of 0.88 occurred at the mid- season is less than the values listed in FAO -33 and FAO -56 by about 16.2% and 10.2%, respectively. During the initial growth stage the actual K_C value was 33.3% and 20.0% higher than FAO-33 and -65, respectively. Nevertheless, during the crop development and late- season growth stages actual K_C values were approximately close to the FAO -33 and FAO -65 K_C values. The average seasonal actual K_C value of 0.73 was identical and close to the FAO-56 K_C value and 1.40% higher than FAO-33 K_C value. These results reflected the difficulty in extrapolating crop coefficients to other environments, and also applying crop coefficient in individual year with differing crop

development patterns. Hence, this attempt is needed to experimentally verify the estimates locally for optimum irrigation planning and management.

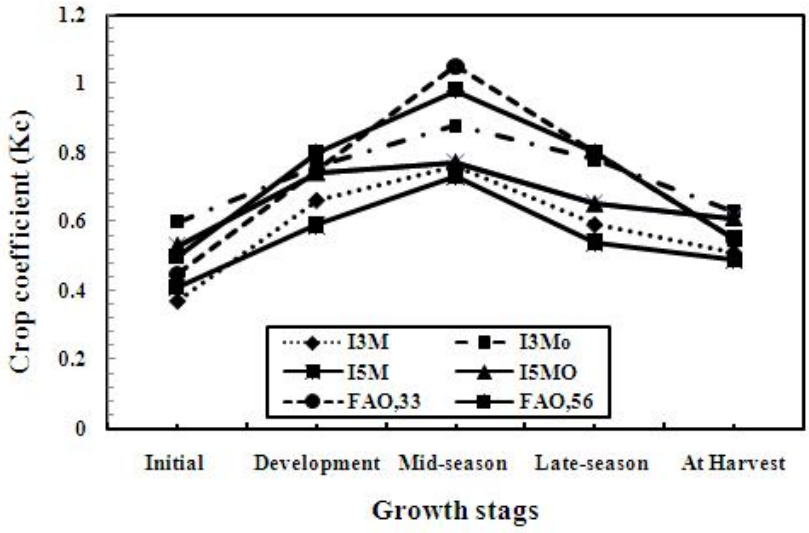

Fig. 2. Actual crop coefficient of peanut (K_C) under different treatments compared to the values of K_C listed in FAO-33 and- FAO 56.

Table 6. Comparison between calculated and reported FAO peanut crop coefficients (K_C) for different growth stages for the control treatment (I_3M_o).

Growth stage	ET_O mm/day	ET_C mm/day	calculated K_C	Reported FAO K_C	
				FAO, 33	FAO, 56
initial	5.66	3.40	0.60	0.45	0.50
Development	6.49	4.90	0.76	0.75	0.80
Mid-season	6.1	5. 34	0.88	1.05	0.98
Late- season	5.26	4.10	0.78	0.80	0.80
At harvest	5.20	3.25	0.63	0.55	0.55
Seasonal Average			0.73	0.72	0.73

Water Use Efficiency (WUE) and Irrigation Water Use Efficiency (IWUE), kg/m^3:

As shown in Fig (3), WUE and IWUE values varied considerably among the treatments. Applying rice straw mulch increased both of WUE and IWUE. Mulch produced a more favorable soil water regime compared with the bare soil treatments that significantly increased kernels yield and decreased both of ET_C and AIW and consequently increased water use efficiency. I_3M and I_5M treatments resulted in the highest values of WUE and IWUE (0.6, 0.6) and (0.47, 0.48) kg/m^{3,} respectively. Meanwhile, I_5M_O treatment had the lowest values of WUI and IWUE, which were 0.36 and 0.28 kg/m^3, respectively. This might be attributed to the increased amount of water applied in I_5M_O treatment resulting a higher crop water use without a corresponding increase in yield. These results confirmed that better management of

available soil moisture content during the growing season , as well as accurate estimation of ET_C and K_C can be effective ways for better irrigation management , maximizing yield and consequently optimizing the economic return.

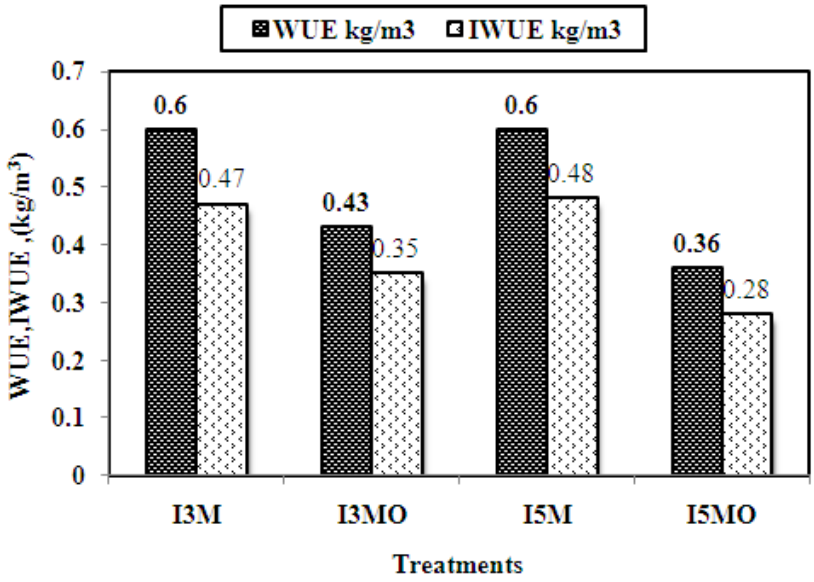

Fig. 3. Water use efficiency (WUE) and irrigation water use efficiency (IWUE), kg/m^3 as affected by irrigation and mulching treatments.

CONCLUSION

It could be concluded that better crop growth higher yield and quality were observed in the mulched plots as compared to non-mulched plots under the same irrigation treatments. Also, irrigation every three days was more pronounced than the effect of irrigation every five days. Maximum pods yield and total kernels yield were 1658.80 kg/fed and 1176.00 kg/fed, respectively obtained with I_3M treatment. An increase in the tested quality parameters such as shelling percent, protein and oil percentages, of 8.9, 4.40 and 2.13% was obtained with I_3M treatment as compared to the control treatment (I_3M_O). Applying rice straw mulch conserved irrigation water by about 14.37 and 21.62% with I_3 and I_5 treatments, respectively. Maximum values of WUE were 0.6 and 0.6 kg/m^3 for I_3M and I_5M, respectively. Meanwhile, minimum values of IWUE were 0.48 and 0.47 kg/m^3 for I_5M and I_3M, respectively. The maximum crop coefficient (K_C) value of 0.88 occurred during July, however the average K_C values of peanut at El-Bustan area was 0.73, which was close to the FAO listed values. These results revealed that precise management of the available soil moisture content in the course of the growing season, and accurate estimation of ET_C as well as, developing site- and cultivar-specific K_C value can be effective ways for appropriate irrigation scheduling and water allocation, saving water, maximizing yield and consequently optimizing the economic return.

REFERENCES

1. Abdrabbo A. Abou-Kheira, 2009. Macromanagement of deficit –irrigated peanut with sprinkler irrigation. Agricultural Water Management 96 ,2009:1409-1420.
2. Allen, R. G. Pereira,L.S. rase, D. and Smith, M.1998. Crop evapotranspiration guide lines for computing crop water requirements. FAO irrigation and drainage paper, 56 Rome.
3. AOAC, Association of Official Agricultural Chemists. 1975. Official methods of analysis of association of official agriculture chemists.12th Ed. AOAC. Wash., USA.
4. Attia, M. M. and K. M. Hammad. 1999. Drip irrigation scheduling of peanut in sandy soil. Mansoura Univ. J. Ag. Sci. 24(11):7059-7069.
5. CoHort, Software. 1986. Costat 6.0 P.O. Box 1149, Berkeley, C A 94701, USA.
6. Doorenbos, J. and A. H. Kassam. 1986. Yield response to water. Irrigation and Drainage Paper No.33, FAO. Rome, Italy.
7. Ghosh, P. K., Devi Dayal, K. K.,bandyopadhyyay and M., Mohanty. 2006. Evaluation of straw and polythene mulch for enhancing productivity of irrigated summer groundnut. Field Crop Research, 99:76-86.
8. Gouranga, K. and K., Ashwani. 2007. Effect of irrigation and straw mulch on water use and tuber yield of potato in eastern India. Agricultural water management, 94(2007):109-116.
9. Hansen, V.E., O.W. Israelsen and G. E. Stringham. 1979. Irigation Principles 4th Ed. John Wiley and Sos, New York, USA.
10. Hartz, T. K., 1993. Drip irrigation scheduling for fresh –market tomato production. Hortscience 28, 35-37.
11. Kamal, H. A., A. H. Gomaa and E. A. Farag. 2010. Peanut crop response to non-uniformity of irrigation application under sprinkler system performance. The 17th.Annual Conference of the Misr Society of Ag. 27(4):1193-1211.
12. Khalifa, E. M. and M. K. El-nemr. 2011. Econmical operation of drip irrigation system with rice straw mulching. Misr j.Ag. Eng., 28(3):650-661.
13. Mohsen, A. El-Adl, 2001.Sprinkler irrigation and fertigation effects on peanut production. Misr. J. Ag. Eng., 18(1):75-88.
14. Plaut, Z. and M. Ben-Hur. 2005. Irrigation management of peanut with moving sprinkler system, runoff, and water use efficiency. Argon. J. 97:1202-1208.
15. Rao.N., R.C. Sander Singh, M. V. K. Sivakumar, K. L. Srivastava and J. H. willams. 1985. Effect of water deficit at different growth phases of peanut 1-Yield response. Agron. J. 77:549-553.
16. Raskar , B.S. and P.G. Bhoi. 2003. Response of summer ground nut in irrigation regimes and evaporation suppressants. Indian J. Agric. Sci., 73(2):82-85.
17. Reddy, T. Y., V. R., Reddy and V. Anhumazhi. 2003. Physiological responses of groundnut to drought stress and its amelioration. Plant growth regul. 41:75-88.

تأثيرادارة الري بالرش والتغطية بالقش علي الإنتاجية والإستهلاك المائي ومعامل المحصول للفول السوداني في الأراضي الرمليه

عبد الحليم محمد زيتون ، آمون القمص جرجس و خليل عبد الحليم علام

معهد بحوث الهندسة الزراعية – مركز البحوث الزراعية – الدقى – الجيزة.

يهدف هذا البحث الي دراسة. تأثيرادارة الري بالرش والتغطية بالقش علي الإنتاجية والإستهلاك المائي ومعامل المحصول للفول السوداني في الأراضي الرمليه. لتحقيق هذا الهدف أجريت تجارب حقلية بمنطقة البستان بالنوبارية–محافظة البحيرة خلال الموسم الصيفي ٢٠١٣م. تم تصميم التجربة إحصائياً بإستخدام القطع المنشقه في ثلاث مكررات حيث تم تمثيل معاملات الري (الري كل ثلاث ايام I_3 والري كل خمس ايام I_5) بالقطع الرئيسية كما مثلت معاملات التغطية بالقش (M) وعدم التغطية (M_O) بالقطع المنشقة. وكانت أهم النتائج المتحصل عليها كالآتي:

أظهرت معاملات التغطية بالقش تأثيراً ملحوظاً علي معدلات النمو والإنتاجية ، كما كان تأثير معاملات الري كل ثلاث ايام (I_3) أكثر وضوحاً علي المعاملات تحت الدراسة. سجلت المعامله (I_3M) أقصي طولاً للنبات، عدد القرون للنبات، وزن القرون للنبات، أجمالي الوزن البيولوجي، وزن ١٠٠ حبة، إجمالي وزن القرون وإجمالي وزن الحبوب وقدرها ٦٥سم، ٣٩,٤٥، ٥٣,٢٠جم، ٤٠١٢,٠٥ كجم/فدان، ٦٧.١٠جم، ٦٥٨,٨٠ كجم/فدان و١١٧٦,٠٠كجم/فدان علي الترتيب. كما لوحظ أن هناك زيادةً في معايير مقاييس الجودة ،ممثلةً في نسبة التقشير، النسبة المئوية للمحتوي من البروتين والزيت في الحبوب وقدرها ٨,٩، ٤,٤٠ و٢,١٣٪ علي الترتيب مقترنةً بالمعاملة (I_3M) ومقارنةً بمعاملة الكنترول (I_3M_O). قدرت قيمة البخرنتح القياسي (ET_O) خلال موسم النمو للفول السوداني بقيمة وقدرها ٧٥٢,٢٥ مم. كما سجلت معاملة الكنترول أقصي معدل للإستهلاك المائي، (ETC) وأعلي معدل للماء المضاف، (AIW) وقدره ٢٤١٥، ٢٩٥٢,٦٠ م٣/فدان، علي الترتيب. كما أدت التغطية بالقش الي توفير في كميات مياة الري وقدرها ١٣,٤ و٢١,٦٢٪ للمعملات (I_3) و(I_5) علي الترتيب. كما سجلت المعاملة (I_3M) والمعاملة (I_5M) أقصي قيمة لكفاءة استحدام المياه (WUE) وقدرها ٠,٦٠ كجم/م٣، بينما سجلت المعاملات (I_3M) و(I_5M) أقصي كفاءة لأستخدام مياه الري (IWUE) وقدرها ٠,٤٧و ، ٠,٤٨ كجم/م٣ علي الترتيب. هذا وقد تم تسجيل أعلي قيمة لمعامل المحصول (K_C) وقدره ٠,٨٨ في شهر يوليو وهي أقل من مثيلاتها المنشورة في FAO-33 وFAO-56 بمقدار ١٦,٢ و١٠,٢٠٪، علي الترتيب. كما بلغت القيمة المتوسطة لمعاملات المحصول ٠,٧٣ والتي سجلت توافقاً نسبياً مع مثيلاتها المنشورة في FAO. هذا وقد خلصت الدراسة الي أن الإدارة الجيدة للمياه المتاحة علي مدار موسم النمو متزامنةً مع التطبيقات الزراعية والتي من شأنها تقليل البخر والحفاظ علي مستوي الرطوبة في منطقة الجذور عند الحدود المناسبة والمسموح بها لنمو النبات بصورة صحية وكذلك التقدير الدقيق للإحتياجات المائية للنبات وإستنباط معامل المحصول متوافقاً مع الظروف البيئية المحيطة وصنف وسلالة المحصول المنزرع والذي من شأنه تطبيق جدولة مناسبة لمياه الري والذي يؤدي بدوره الي توفير لمياه الري بالإضافة الي معظمة المحصول و من ثم تحقيق عائداً مناسباً.