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RESEARCH ARTICLE

EFFECT OF TWO SPRINKLER IRRIGATION TYPES ON WHEAT I-UNIFORMITY,VEGETATIVE GROWTH AND YIELD

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ABSTRACT

It is common to use the sprinkler irrigation system on large-scale irrigation intensive crops in the Egyptian desert. The cultivation and production of wheat crop depends basically on sprinkler irrigation system in Egypt. Two field experiments were conducted in two successive season (2011/2012 and 2012/2013) at two sites El-EmamMalek village and NRC Farm (according to the cultivation periods), Nubaria, Behaira Governorate to study the effect of two types of sprinkler irrigation system and three water amount on vegetative growth, WUE, and yield of wheat crop (*Triticumaestivum L. cv. Gemmaiza 9, Varity*). The results could be summarized as following:Uniformity coefficients (% UC) had been practical evaluated in the two experimental farmsand the results were 86.7 and 74.0 % under using Permanent and Simi portable sprinkler irrigation systems, respectively.Results of Distribution uniformity (% DU) were 78.8 and 58.7 % under Permanent and Simi portable sprinkler irrigation systems, respectively. The effects of the sprinkler irrigation type on all studied parameters were significant at the 5% level except seed index. TheSemi PortableSystem(SPS)resulted in undesirable mechanical damage of some wheat plants.Moving the lateral lines in SPS system after irrigation each 4 days in a wet soil caused soil compaction, poor aeration and root growth impedance.Decreasing the irrigation water from I_{100} to I_{50} had positive effects on water use efficiency of grain yield $(WUE)_g$ and negative ones on all other parameters.Moving the lateral lines in SPS system after irrigation each 4 days in a wet soil caused soil compaction, poor aeration and root growth impedance.Differences in most parameters among treatments were significant at the 5% level.

INTRODUCTION

In the sprinkler method of irrigation, water is sprayed into the air and allowed to fall on the ground surface somewhat resembling rainfall. The spray is developed by the flow of water under pressure through small orifices or nozzles. The pressure is usually obtained by pumping. With careful selection of nozzle sizes, operating pressure and sprinkler spacing the amount of irrigation water required to refill the crop root zone can be applied nearly uniform at the rate to suit the infiltration rate of soil.

One of the main challenges of world is water and food security. The increasing food demand and decreasing water allocation suggest that the agricultural sector has to increase agricultural water productivity for producing more food with less water **(Cai and Sharma 2010)**. This challenge in arid regions of the world, such as Egypt, is more complicated. Agriculture sector is the main user of water in developing countries. In Egypt, 80% of the supplied water (70 billion cubic meters) belongs to this sector. Hence, increasing water productivity, the attained crop yield or crop value per cubic meter of water, in this sector has very an important role in water shortage problems relief. Water is a critical agricultural input in arid regions that has high effect on crop yield and crop production. In these areas agriculture is no beneficial or even impossible without irrigation. Therefore, irrigation management and irrigation systems upgrading have a high important role in water productivity.

According to **FAO (1979)** the total growing season of winter wheat ranges from 180-250 days to mature. Mean daily temperature for optimum growth and tillering is between 15 and 20^{o} C. The crop is moderately tolerant to soil salinity. For high yields it's water requirements vary from 450 to 650 mm depending on climate and length of the growing season.

MALR (2012) reported that the wheat cropped area in 2010/2011 is about 3048601 fed (fed = 4200 m^2). Winter wheat is able to adjust its growth better in relation to soil water deficit **(FAO, 1979).** Winter wheat is capable of depleting the soil water content to a level lower than many other crops. **(Haise*et al*, 1955)**. This is due to the deep, fibrous and profuse nature of the root system. The rapid increase in population and the limited water resources in many parts of world led to an ever increasing food problem to narrow the gap between food production and consumption we have to rationalize our limited natural resources such as soil and water.**FAO (1979)** stated that a good yield of wheat under irrigation is 4 to 6 ton hec^{-1} (12-15 % moisture) and water utilization efficiency for harvested grains yield is about 0.8 to 1 kg m^{-3}.

Irrigation systems evaluation is done based on irrigation efficiency indices such as uniformity coefficient, distribution uniformity and application efficiency. These indices affect the irrigation system design and irrigation hydromodule determination. In addition, success of irrigation projects usually expresses with these efficiency indices. In many new studies, water productivity (WP) has been introduced as a more comprehensive index for evaluation of water management and study of water use efficiency in agriculture **(Kijne et al., 2003; Wichelns, 2002)**. Both irrigation efficiency and WP indices have useful applications in irrigation and water management systems evaluations and related studies and each of them will be appropriate regarding to object study. Some of manager and experts prefer WP and some of them prefer irrigation efficiency indices in their decisions and studies **(Kijneet al., 2003; Wichelns, 2002).** This issue has introduced big confusions in irrigation and water management systems **(van Halsema and Vincent, 2012)**. Therefore, determination of irrigation efficiency indices and WP index relationships can help agreement between decision makers, engineers, researchers and water users in planning, designing and operating strategies of irrigation system adoption. Water application uniformity in the field is expressed with uniformity coefficient (CU) and this index is the basic parameter in irrigation systems design and evaluation. Increase of CU through irrigation system improvement or system upgrading requires investment. The economic analysis should be applied in this investment regard to increased yield through CU increase. Irrigation adequacy (Pa) is another key management and operational parameter that defines as the percentage of the field receiving the desired amount of water or more. This parameter affects the total applied water in the field and hence affects crop yield and WP. Various studies have been carried out on water distribution and irrigation system effects on crops yield. Spatial soil moisture variation and irrigation distribution uniformity had been analyzed theoretically by **Warrick and Gardner (1983). Ayars et al. (1991)** studied relationships between sugar beet and cotton yield with irrigation uniformity and reported uniformity effects on crops yield. **Moteos et al. (1997)** studied sprinklers uniformity on cotton yield.

Ortega Alvarez et al. (2004), in study of set sprinkler irrigation system in semi-arid region of the Spain reported that economic benefit for barely, maize, garlic, onion crops will attain with high uniformity coefficient (90 %).**Colaizzi et al. (2005)** in study of water use efficiency in sprinkler and trickle irrigation systems reported that trickle irrigation is the best system according to this index. **Grassini et al. (2011)** in study of agronomic practices impacts on maize yield reported that applied irrigation water was 41 and 20% less under pivot and conservation tillage than under surface irrigation and conventional tillage, respectively.

Many studies had shown that main changes in irrigation management are essential to access optimize water use. For example, deficit irrigation as an effective water planning strategy for water use efficiency improvement is introduced **(Kirda and Kanber, 1999; English, 1990; Van Halsema and Vincent., 2012**). This strategy can be applied with decreasing of adequacy level in irrigation design and management. Water-yield function has the key role in deficit irrigation optimization. All of studies and methodologies in the field of optimum water allocation in drought conditions use one form of this function **(Wichelns, 2002).**

Water supply is a major constraint to crop production. Efficient use of irrigation water is becoming increasingly important, and alternative water application methods such as sprinkler irrigation, may contribute substantially toward making the best use of water for agriculture and improving irrigation efficiency especially under cereal crop production**Phocaides, (2000) and Abd El-Kader et al (2010)**

Aim of this research work is studying the effect of two types of sprinkler irrigation systems and different water amounts through two growing seasons (2011/2012 and 2012/2013) on wheat vegetative growth and yield at western Egyptian desert.

MATERIALS AND METHODS

Two field experiments were conducted in two successive season (2011/2012 and 2012/2013) at two sites El-EmamMalekvillage and NRC Farm (according to the cultivation periods), Nubaria, BehairaGovernorate, the study area located to the west of the Nile Delta between latitudes 30° 31'44" & 30°36'44"N and longitudes 30°20'19" & 30°26' 50"E to study the effect of two types of sprinkler irrigation system and different water amount on vegetative growth, WUE, and yield of wheat crop (*Triticumaestivum*L. *cv. Gemmaiza 9,* Varity)

Evaluation and measures of irrigation systems uniformity:

There are many measures of sprinkler irrigation uniformity in use, and a discussion of all of them is beyond the scope of this paper. Two commonly used measures will be presented here to facilitate comparisons in some later examples. The first is the Uniformity Coefficient (UC) proposed by J.E. Christiansen in 1942.

$$UC = 100(1-[D/M]) \quad (1)$$

Where:
UC = Uniformity Coefficient (%)
D = Average Absolute Deviation of Irrigation Amounts
M = Average of Irrigation Amounts
The second measure is the Distribution Uniformity (DU), proposed in one form or another by various workers.

$$DU = 100 (1-[LQ/M]) \quad (2)$$

Where:
DU = Distribution Uniformity (%)
LQ = Average of the Lowest 1/4 of the Irrigation Amounts
M = Average of Irrigation Amounts
These two uniformity measures are (approximately) related by the equations:

$$UC = (0.63) (DU) + 37 \quad (3)$$

$$DU = (1.59) (UC) - 59 \quad (4)$$

Christiansen developed UC to measure the uniformity of sprinkler systems, and it is most often applied in sprinkler irrigation situations. UC has been occasionally applied to other forms of irrigation, though. DU has been applied to all types of irrigation systems.

Evaluation steps of two types of sprinkler irrigation systems under studying:

Every sprinkler irrigation system under study was practical evaluated in the two different farms using 20 catch can containers. The depth caught in each container is given below as showing in Table (3) in results partition.

Soil, Water, Plant Properties Measurements

Some soil physical, chemical and water properties of the studied soil are carried out after **(Klute, 1986)**and moisture retention at field capacity and wilting point after**(Rebecca, 2004).** Soils of both investigated sites were sandy loam in texture. Some soil chemical characteristics of the studied two sites were recorded in **Table 1**. Analysis farmyard manure used in the experiments was as follow: 4.85 dSm^{-1} (EC, 1:20), 7.77 (pH, 1:20), 11.2% (OM), 5.4, 0.85 and 1.12% total (N, P and K) and 1:16.5 (C:N ratio).

Wheat Farming Operations

The experiment design was randomized complete block in two factors with three replicates. The area of the experimental plot was 12×14 m^2 (0.04 feddan). Farm- yard manure had been added at the rate of 10 m^3fed^{-1}. The organic manure was thoroughly mixed with 0 - 30 cm of the surface soil layer before planting. Applied fertilizers were 100 kg Superphosphatefed^{-1} (15.5% P2O5) and 50 kg K2Ofed^{-1} (potassium sulphate 48% K2O) were added and mixed well before planting as well as addition recommended dose of nitrogen (100 kg Nfed^{-1}) in two equal doses, 4 and 10 weeks after completely germination. Wheat grains (*Triticumaestivum*L. *cv*. Gemmaiza 9) were broadcasted on the soil at the rate of 100 kg/fed. At the maturity stage, the plants were harvested and separated into grains and straw.

Table(1) Soil properties of the studies sites.

Site	pH	EC dSm^{-1}	OM %	$CaCO_3$	(Soil water content %vb) FC	WP	AW
EmamMalek	8.1	2.3	0.5	5.6	9.5	3.6	5.9
NRC Farm	8.2	2.6	1.3	3.8	12.6	4.7	7.9

pH: (1.25), EC: electrical conductivity in the extracted soil paste, OM organic matter, FC: field capacity, WP: wilting point, AW available water, vb volume basis.

Production was recorded and prepared for analysis. Soil samples 0 - 20 cm) were taken after wheat harvest for determine some soil hydro-physical and chemical characteristics such as soil bulk density (gm/cm^{-3}), **(Rebecca,**

2004). Soil hydraulic conductivity (HC) was measured in the laboratory under a constant head technique (**Klute and Dirksen, 1986)** using the following formula:

$$HC = (QL)/(At\ \Delta H) \quad (5)$$

where: HC: water quantity (cm) flowing through saturated soil sample/unit time/ unit area, Q: volume of water flowing through saturated soil sample per unite time (L^3/t), A: cross sectional flow area (L2) L: length of the soil sample and ΔH: gradient in hydraulic head H/L. Planted area in semi portable sprinkler irrigation system was decreased by 10% relative the permanent one. The reason that in the first one need using more area for moving laterals from place to the second.

Components of sprinkler irrigation system

The components of portable sprinkler system used are shown through Fig . No.1 sprinkler system usually consists of the following components

(i) A pump unit(50 m^3/h)

(ii) Tubings- main/submains and laterals (inside diameters are 150, 110, 90 mm, respectively.

(iii) Couplers

(iv) Sprinker head (l/h)

(v) Other accessories such as valves, bends, plugs and risers.

Semi portable system: The semi portable system used is similar to the portable one except that the location of water source and pumping plant is fixed.

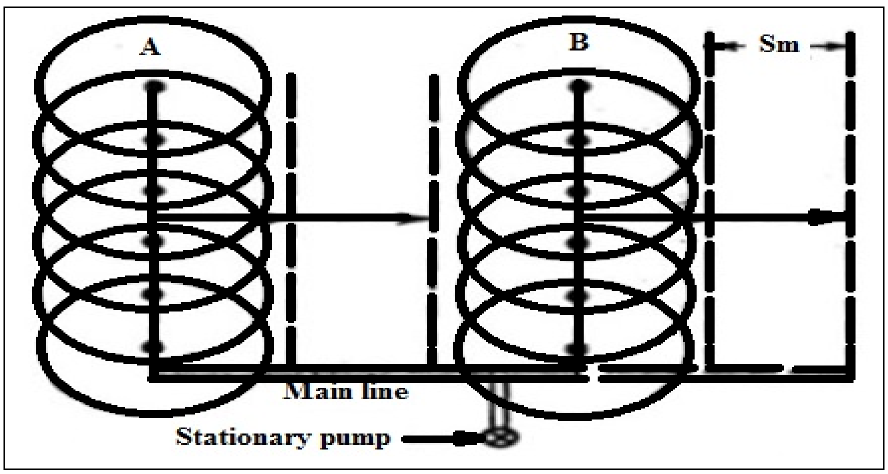

Fig .(1)Semi portable sprinkler irrigation system.

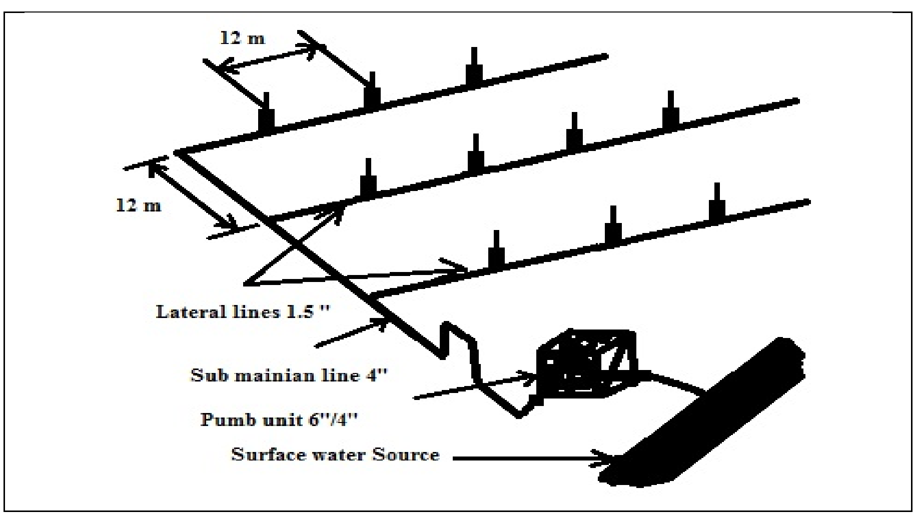

Fig.(2)Permanent sprinkler irrigation system

Permanent system: A fully permanent system consists of permanently laid mains, sub mains and laterals and a stationery water source and pumping plant.

Sprinkler Irrigation System, water requirements and Water Use Efficiency

Irrigation water was applied using sprinkler irrigation system by fixed lateral lines 1.5 inch in diameter distances between sprinkles on the same lateral and among lateral lines were 12 m, Risers height were 1.0 m, sub main and main lines were 4 and 6 inches diameter, respectively. Mean of sprinkler discharge was1.2 m^3h^{-1}at mean operating pressure head of 2 bars. Mean of wind speed was 1.5 m sec^{-1}.

Number of sprinklers on every lateral line were 14. Irrigation Efficiency of systems used were 78 % for Semi portable system and 83% for permanent system.Irrigation water amounts were estimated using the reference evapotranspiration and crop coefficients after **(Allen et al, 1998)** while the irrigation timing was determined using a water balance, a common practice among. Intervals were 4 days for all treatments; calculated amount of water requirements was (550mm $season^{-1}$) 2310 $m^3fed^{-1}season^{-1}$.

Table (2) Water requirements for wheat crop at Nubaria sites, Egypt.

Month	**Dec**	**Jan**	**Feb**	**March**	**April**	**May**
Days	**31**	**31**	**29**	**31**	**30**	**31**
ET (mm/day)	2.8	6.3	5.9	4.2	7.4	2.0
Kc	0.4	0.4	0.8	1.3	0.5	0.4
ETc(mm/day)	1.1	2.5	4.7	5.4	3.7	0.8
Growth stage	**Planting (Establishment)**	**Rapid vegetative growth**		**Flowering seed fill**	**Maturity and harvesting**	
IRn(mm/month)	33.1	77.6	136.4	167.5	111.1	24.9
IRg (mm/month)	36.4	85.3	150.0	184.4	122.0	27.4

IRn= Net irrigation requirements, IRg= Gross irrigation requirements.

Field water use efficiency (FWUE) was calculated after**(Michael, 1978).**

$$(FWUE) = Y/WR \qquad (6)$$

Where:

Y = Seed yield (kg/fed–1)

WR = The total amount of water applied in the field (m3/fed–1).

Crop water use efficiency (CWUE): It was calculated as follows **(Michael, 1978).**

$$(CWUE) = Y/WCU \qquad (7)$$

Where:

Y= Seed yield (kg fed^{-1}) and WR = Actual water consumptive use (m^3fed^{-1}).

Data were subjected to analysis of variance in randomized complete block design as factorial (two factors) and means were separated according to LSD test, correlation and multiple regressions were estimated after computer's program provided by using the SAS program (**SAS Institute, 2001).**

RESULTS AND DISCUSSION

1-Uniformity coefficient (%UC) and Distribution Uniformity (%DU)of Permanent sprinkler irrigation system:

Data in Table (3) showing the practical evaluation and collected data of sprinkler systems under study,we can using the data from Table (3) and Equations 1 and 4 as following to calculate % UC and % DU of permanent and Simi portable sprinkler irrigation systems.

d_{LQ} (Number of quarter cans ranked) = average of cans (1-5) of ascending ranked = 3.40

M = average of cans (1-20) = 4.46

D = average absolute |di-dz| = 0.6

Applying in Equation (1):UC = 100 (1-[D/M])

UC (%) = 100 (1 - [0.6 / 4.5] = 100 * 0.867 = 86.7 %

DU = Distribution Uniformity (%)

Applying in Equation (4): DU = (1.59) (UC) - 59 = (1.59 * 86.7) – 59 = 78.8 %

Table (3) Practical evaluation parameters of permanent and Simi portable sprinkler irrigation systems.

CAN No.	Permanent sprinkler irrigation system			Simi portable sprinkler irrigation system		
	Water depth(cm)	di (Ascending Ranked)	Absolute |di-dz|	Water depth(cm)	di (Ascending Ranked)	Absolute |di-dz|
1	4.5	2.8	1.7	5.1	2.4	0.6
2	4.9	3.3	1.2	3.3	2.8	0.2
3	4.1	3.5	1.0	4.2	3.2	0.2
4	5.3	3.6	0.9	3.8	3.2	0.2
5	4.7	3.8	0.7	4.1	3.3	0.3
6	3.5	4.1	0.4	4.7	3.5	0.5
7	5.6	4.2	0.3	2.8	3.6	0.6
8	3.8	4.3	0.2	2.4	3.7	0.7
9	4.8	4.4	0.1	4.5	3.8	0.8
10	4.4	4.5	0.0	3.6	3.8	0.8
11	4.6	4.6	0.1	3.7	4.1	1.1
12	5.3	4.7	0.2	4.2	4.1	1.1
13	3.3	4.8	0.3	3.2	4.2	1.2
14	2.8	4.8	0.3	5.1	4.2	1.2
15	5.1	4.9	0.4	3.8	4.2	1.2
16	4.2	5.1	0.6	4.2	4.5	1.5
17	4.3	5.3	0.8	3.5	4.7	1.7
18	4.8	5.3	0.8	4.8	4.8	1.8
19	3.6	5.6	1.1	4.1	5.1	2.1
20	5.6	5.6	1.1	3.2	5.1	2.1
Average	**4.46**	**Quarter Avg. (1-5)=3.4**	**0.6**	**3.91**	**Quarter Avg. (1-5)=2.98**	**1.0**

2- Uniformity coefficient (%UC) and Distribution Uniformity (%DU)of Simi portable sprinkler irrigation system:

d_{LQ} (Number of quarter cans ranked) = average of cans (1-5) of ascending ranked = 2.98
M = average of cans (1-20) = 3.91
D = average absolute |di-dz| = 1.0
Applying in Equation (1):UC = 100 (1-[D/M])
UC (%) = 100 (1 - [1.0 / 3.91] = 100 * 0.74 = 74.0 %
DU = Distribution Uniformity (%)
Applying in Equation (4): DU = (1.59) (UC) - 59 = (1.59 * 74.0) – 59 = 58.7 %

Uniformity coefficients (% UC) had been practical evaluated in the two experimental fields for irrigation systems types under studying and resulted were 86.7 and 74.0 % under using Permanent and Simi portable sprinkler irrigation systems, respectively.Distribution uniformity (% DU) were 78.8 and 58.7 % under Permanent and Simi portable sprinkler irrigation systems, respectively. These acceptable results for the two sprinkler irrigation systems types under study according to **Kunde,(1985), Solomon, (1983) and Solomon,(1987).**

3-Main effects of treatments on the studied parameters:

Data of Table (4) showed the main effect of the growth seasons, sprinkler system, and irrigation treatment on spike number m^{-2}, seed index, peduncle length (cm), plant height (cm), yield of both the biomass, grain (Kg fed^{-1}), and water use efficiency (Kg grain per m^3 of irrigation water (kg m^{-3}).

According to the values of all the studied parameters, the growing seasons could be put in the following ascending order: 2011/2012 < 2012/2013. Differences in the parameters values between the two seasons were significant at the 5% level. Also, the irrigation systems types could written in the following ascending order: SPS < PS. The effects of the sprinkler irrigation type on all studied parameters were significant at the 5% level except seed index.

Decreasing the irrigation water from I_{100} to I_{50} had positive effects on $(WUE)_g$ and negative ones on all other parameters. Irrigation treatments could be arranged in the following ascending order: $I_{100} < I_{75} = I_{50}$ and $IR_{50} < IR_{75} < IR_{100}$ for $(WUE)_g$and the other parameters, respectively. Differences in most parameters among treatments were significant at the 5% level. The exceptions were between irrigation treatments (I_{100} ; I_{75}) and (I_{75} ; I_{50})in the case of seed index and $(WUE)_g$, respectively.

4. Interaction effects of the treatments:

Table (5) indicated that the interaction: Sprinkler irrigation type I X Season of growth have significant effects on the yield of both biomass, grains and $(WUE)_g$ o the 5% level. The maximum and the minimum values were obtained from the interactions: PS X I_{100} X 2013 and SPS X I_{50}X 2012, respectively. Taking in to consideration the effect of irrigation treatments on soil moisture stress before the next irrigation they could be arranged in the following ascending order: $I_{100} < I_{75} < I_{50}$and the cumulative effect of soil moisture stress increased with time from germination to maturity.

Table (4): Effect of different sprinkler irrigation systems and different water amounts on Wheat vegetative growth.

Season (I)	Sprinkler Irrigation (II)	Water amount (% ETo) (III)	No of Spikem^{-2}	1000 grain Weight(g)	Peduncle length (cm)	Plant Height (cm)
2012	Simi portable system	100	523 a	38.8 a	29.5 a	98.2 a
		75	516 b	36.2 b	27.3 b	95.7 b
		50	508 c	22.5 c	21.7 c	75.5 c
	Permanent system	100	531 a	40.6 a	30.2 a	99.7 a
		75	520 b	37.3 b	28.6 b	96.6 b
		50	511 c	28.1 c	22.8 c	76.9 c
	Mean		**518**	**34**	**27**	**90**
2013	Simi portable system	100	526 a	42.5 a	32.9 a	102.6 a
		75	520 b	41.6ba	30.1 b	100.2 b
		50	518cb	29.2 c	23.5 c	79.6 c
	Permanent system	100	537 a	44.6 a	34.6 a	105.8 a
		75	530 b	42.7 b	33.2 b	103.6 b
		50	527cb	33.1 c	25.7 c	84.3 c
Mean			**526**	**39**	**30**	**96**
LSD 0.05			4	2.3	1.5	0.6

Therefore the date on hand could be due the following factors:

1- The increase in soil moisture stress in the root zone has a depressive effect on lower leaves firing and tillering.
2- Lower leaves firing and decreasing tillering led to lower photosynthesis process and subsequently all the studied parameters.
3- At the time of flowering root growth may be very much reduced by soil moisture stress and may even cease and considerable damage can be caused leading to yield loss. Farmers have to put in mind that this loss cannot be recovered by providing adequate water supply during the later growth period.
4- Pollen formation and fertilization can be seriously affected under heavy soil moisture stress.
5- During the time of head development and flowering, water shortage will reduce both heed No./plant, head length and grain No./head.
6- Water deficit during the yield formation caused grains shriveling and grain weight reduction.
7- The climate was hot in addition to hotter and stronger wind during the yield formation in season 2012 relative to season 2013.
8- The residual effect of the manure added in the 1st year extended to the 2nd one.
9- The SPS system resulted in undesirable mechanical damage of some wheat plants.

10- Moving the lateral lines in SPS system after irrigation each 4 days in a wet soil caused soil compaction, poor aeration and root growth impedance.
11- Under both SPS and dense and to some extent high wheat plant we do expect lower water distribution uniformity due to the difficulty in straight forward lateral lines a lining and watching water leakage from the joints.
12- WUE of SPS < PS.

Table (5): Effect of different sprinkler irrigation systems and different water amounts on Wheat yield and WUE.

Season (I)	Sprinkler Irrigation (II)	Water treatment (% ETo) (III)	Water amount ($m^3 fed^{-1}$)	Biomass (Kg fed^{-1})	Grain yield (Kg fed^{-1})	WUE (Kg m^{-3})
2012	Simi portable system	100	2185.0	4396 a	3767 a	1.7 a
		75	1638.8	4384 b	3521 b	2.1 b
		50	1092.5	4189 c	2207 c	2.0cb
	Permanent system	100	2185.0	4487 a	3858 a	1.8 a
		75	1638.8	4465 b	3632 b	2.2 b
		50	1092.5	4268 c	2387 c	2.1cb
	Mean			**4365**	**3229**	**2.0**
2013	Simi portable system	100	1987.0	4496 a	3975 a	2.0 a
		75	1490.3	4476 b	3841 b	2.6 b
		50	993.5	4286 c	2437 c	2.5cb
	Permanent system	100	1987.0	4585 a	4088 a	2.1 a
		75	1490.3	4564 b	3953 b	2.7 b
		50	993.5	4364 c	2523 c	2.5cb
	Mean			**4462**	**3470**	**2.4**
	LSD 0.05			8	12	0.6

Table (6): Main effect of sprinkler system and water amount on wheat vegetative growth and yield.

Treatments	No of Spike m^{-2}	1000 grain Weight(g)	Peduncle length (cm)	Plant Height (cm)	Biomass (Kg fed^{-1})	Grain yield (Kg fed^{-1})	WUE (Kg m^{-3})
2012	518.2b	33.9d	26.7c	90.4f	4364.8e	3228.6f	1.9b
2013	526.3a	39.0b	30.0b	96.0c	4461.9c	3469.5c	2.4a
SPS	518.5b	35.1c	27.5c	92.0e	4371.2e	3291.3e	2.1b
PS	526.0a	36.5c	29.2b	94.5d	4455.5d	3406.8d	2.2a
100	529.3a	41.6a	31.8a	100.8a	4491.0a	3922.0a	1.9b
75	521.5b	39.5a	29.8b	99.0b	4472.3b	3736.8b	2.4a
50	516.0c	28.2e	23.4d	79.1g	4276.8f	2388.5g	2.3a

SPS: Simi portable sprinkler irrigation system and PS: Permanent sprinkler irrigation system.

CONCLUSION

It could be concluded that:

1- Uniformity coefficients (% UC) had been practical evaluated in the two experimental fields for irrigation systems types under studying and resulted were 86.7 and 74.0 % under using Permanent and Simi portable sprinkler irrigation systems, respectively.
2- Distribution uniformity (% DU) was 78.8 and 58.7 % under Permanent and Simi portable sprinkler irrigation systems, respectively.

3- The effects of the sprinkler irrigation type on all studied parameters were significant at the 5% level except seed index.
4- Decreasing the irrigation water from I_{100} to I_{50} had positive effects on $(WUE)_g$ and negative ones on all other parameters.
5- Differences in most parameters among treatments were significant at the 5% level.
6- Moving the lateral lines in SPS system after irrigation each 4 days in a wet soil caused soil compaction, poor aeration and root growth impedance.
7- The better production of wheat crop under experiment conditions was in the second season 2012/2013.
8- The permanent sprinkler system gave the highest production of vegetative growth, grain, and biomass.

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