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Management of Sprinkler Irrigation System and Different Egyptian Wheat Varieties for Uniformity, Yield and Water Productivity

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Abstract: Irrigation water management is the act of timing and regulating irrigation water application in a manner that will meet the water requirement of the crop without wasteful of water, fertilizers, and soil degrading. This research work was carried out at Research Station of National Research Center, El-Noubaria, El-Behaira Governorate, Egypt, during the two successive seasons of 2012/2013 and 2013/2014 to study the effect of three water consumptive use levels (100, 75, and 50 %) from (ETc) and four Egyptian wheat varieties (Giza 168, Sids 12, Misr 1, and Misr 2) on irrigation system uniformity, growth, yield and water productivity of wheat. The design experiment was factorial in complete randomized blocks with three replications. Results could be summarized as following: Uniformity coefficients (% UC) Distribution uniformity (% DU) had been practical evaluated in the experimental field for irrigation system types under studying and resulted were 86.7 % and 78.8 %, respectively. In general, the three dimension model indicated that there is high uniformity distribution by using permanent sprinkler system. Wheat yield and yield components: Spikes no/m^2, seed index (SI), grain yield (GY), and water productivity (WP) under 50 % increased relative to 75and 100 % from ETc levels. On the other hand, under Giza 168, Sids 12, Misr 1 and Misr 2: Spikes no/m^2, SI, GY, and WP increased under Giza 168 relative to Sids 12, Misr 1 and Misr 2 verities. It could be conclude that: treatment of 50 % from ETc applied gave the highest values and it was high in the significant differences between results values, so that for best grain yield and water productivity purpose using applied water 50 and 75 % with a varieties of Giza 168 and Sids 12.

Keywords: Sprinkler Irrigation System, Water Consumptive use, ETc, Wheat, Egyptian Varieties, Water Productivity.

1. Introduction

Wheat crop (*Triticum spp.*) is the most important cereal crop in the world in terms of area and production; it is a stable food for more than one third of the world population. In Egypt, wheat is the main winter cereal crop; it is used as a stable food grain for urban and rural societies. The wheat area over the last 10 years (2004-2014) has been expanded from (0.18-0.25 million ha) and the average productivity per ha has been increased from 6.4 to 8.8 million tons during that period. However, total wheat consumption has increased drastically due to overall population growth of about 2.5 % per year. Therefore, Egypt imports about 60 percent of wheat requirements this reflects the size of the problem and the efforts needed to increase wheat production gap, due to extremely limited. It has become essential to improve irrigation water productivity and decrease irrigation demand while keeping up the crop productivity.

Use of sprinkler irrigation system, where smaller amounts of water can be uniformly applied to fields, further helps to achieve higher water use efficiencies [1]. Crops sprinkled with low quality water are exposed in two ways that salts can affect plant growth and yield: direct salt adsorption through the leaves as well as increased soil salinity [2]. The use of the line source sprinkler method has been advocated for obtaining salinity production functions under such conditions [3]. With this method, it is possible to determine the separate and interactive effects of the quantity and salinity of applied water on crop yields.

Irrigations are recommended at times corresponding to the specific growth stages (crown root initiation, early tillering, late jointing/boot, and heading/flowering) of the wheat [4].

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During the growing season of winter wheat, irrigation is a common practice to meet winter wheat's consumption on the water. Drops of sprinklers break aggregated and compact thin surface layers and lead to the formation of a seal or crusts and hard setting, [5] and [6]. Under sprinkler irrigation, pores in topsoil varied with intensity, drop size and the amount of water applied. Porosity reduction is mainly due to size decrease of elongated pores and is associated with the increase of runoff rate, especially in bare soil, [7] and [8]. In a crop field, the water for sprinkler irrigation is intersected by plant canopy, which gives rise to different distribution, [9], [10] and [11]. The effect of sprinkler irrigation on soil structure might be different in winter wheat fields and bare fields.

Water Productivity (WP) is defined as the ratio between grain yield and total evapotranspiration during the growing season. Water use efficiency (WUE) in the last decades has been defined the same. Studies on the effects of irrigation water requirements show that crop yield can be increased and grain quality can be improved while substantially reducing irrigation water volume, [12], [13] and [14]. These studies also show that the relationship between crop yield and seasonal evapotranspiration or water requirements can take different forms and that the empirical coefficients vary with climate, crop type and variety, irrigation water amounts and qualities, soil texture, fertilizer and tillage methods.

The relationship between WP and evapotranspiration or irrigation water requirements or water use also shows high locative and temporal variability. [15] Found that WUE decreased with increasing water amount use, whereas [16] found that WUE did not change with seasonal water requirements.

Under low amounts of irrigation water, reductions in grain yield due to restricted water availability depend on the degree, duration and timing of the imposed soil moisture deficit. The effect of soil water stress on crop yield depends on the particular phonological stage of the crop, and the most sensitive stage can vary regionally, [17].

The aim of the present investigation is to study the evaluate of field uniformity test of permanent sprinkler irrigation system and study the effect of three water amounts, 100, 75, 50 % from (ETc) and four wheat varieties (Giza 168; Sids 12, Misr 1, and Misr 2) on growth, yield and water productivity.

2. Materials and Methods

The present investigation was conducted at National Research Center, El-Noubaria Research Station El-Behaira Governorate, during the two successive seasons of 2012/2013 and 2013/2014 to study the response of four wheat varieties (Giza 168, Sids 12, Misr 1, and Misr 2) to different consumptive water (ETc) on yield components and some technological properties.

Some soil physical, chemical and water properties of the studied soil are carried out after [18] and moisture retention at field capacity and wilting point after [19]. 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 follows: 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).

The experimental design was a factorial including two factors in a completely randomized block design with 3 replicates. The plot area was 16 m^2 (4 x 4). NPK fertilization added according to recommended by Egyptian Agricultural Ministry, while the (ETc) levels were applied as a different amounts of water as follows: Control (100 %), Medium (75 %) and Low (50 %).

Table 1: Soil properties of National Research Centre Research Station, Nubaria sites, Egypt.

Site	pH	EC dSm^{-1}	OM	$CaCO_3$	(Soil water content %vb)		
			%		ETC	WP	AW
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, ETC: field capacity, WP: wilting point, AW available water, vb volume basis.

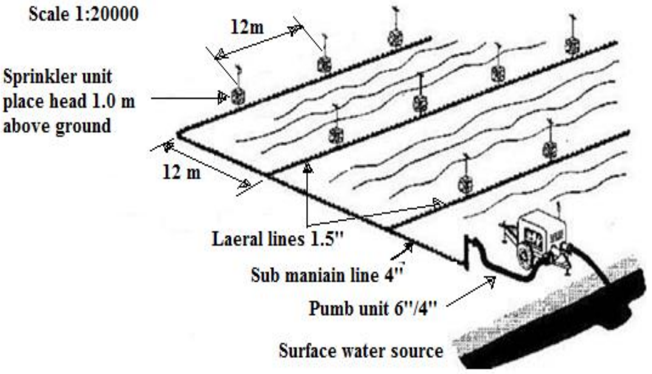

Figure 1: Layout of the fixed sprinkler irrigation system.

Calculated amount of water requirements was (550 mm $season^{-1}$) 5497.8 m^3ha^{-1} $season^{-1}$.Water consumptive use (WCU) was calculated according to [20] by the following equation:

$$Wcu= \sum_{i=1}^{i=n} (\theta 2 - \theta 1) / 100 (DB) (60 / 100) (4200)$$

Where

Wcu = Water consumptive use (m^3/ fed.), n= Number of irrigation, θ2 = Soil moisture (%) after irrigation, θ1 = Soil moisture (%) before the next irrigation, and DB = Bulk density of soil (g / cm^3).

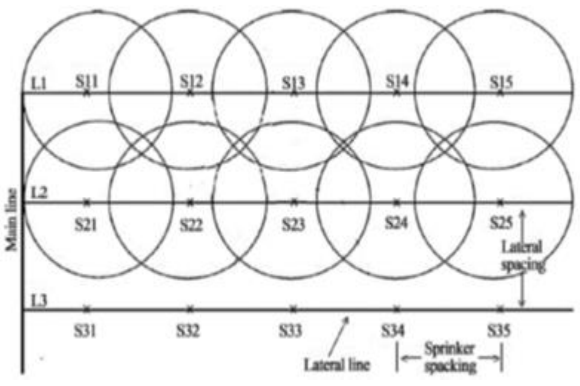

Figure 2: Lay out of the fixed sprinkler irrigation system with detail components and sprinklers overlapping.

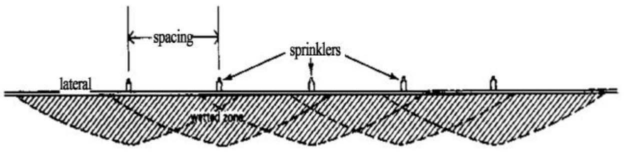

Figure 3: Soil wetted zone within overlapping under the fixed sprinkler irrigation system

Permanent 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 , and 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 , and 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 permanent sprinkler irrigation systems:

A permanent sprinkler irrigation system under study was practical evaluated in NRC farm using 20 catch can containers. The depth caught in each container is given below as showing in Table (2) in results partition.

This character was measured after heading by using a wooden frame of one square meter which put at random on the plants of each plot and the internal fertile spikes were counted and recorded. Samples have been collected at random from grain yield of each plot and then 1000-grain was counted and weighted. Plants in each plot were harvested, and then weigh as a total yield. The harvested plants were threshed and the grains of each plot were collected and weighed. The grain yield was expressed as Kg/ha. This was calculated by subtracting the grain yield from the total yield and converted to ton/ha. Data measurements: Test weight was measured after harvest in 2012/2013 and 2013/2014 using harvested grain yield (Kg/ha).

The investigated main factors and treatments mean were compared using the technique of analysis of variance (ANOVA) and the least significant difference (LSD) between systems at 1 %, [21].

Results and Discussion

Evaluation of the permanent sprinkler irrigation system by field testing:

Sprinkler irrigation system is one of the important irrigation systems in Egypt, and especially using in sandy soils and it must using with high density crops such as wheat crop it under current field condition. In this research work the permanent sprinkler system used with different Egyptian wheat varieties.

Table 2: Evaluation of testing field for permanent sprinkler irrigation system.

Catch cans No.	Water depth(cm)	Di (Ascending Ranked)	Absolute |di-dz|
1	4.5	2.8	1.7
2	4.9	3.3	1.2
3	4.1	3.5	1
4	5.3	3.6	0.9
5	4.7	3.8	0.7
6	3.5	4.1	0.4
7	5.6	4.2	0.3
8	3.8	4.3	0.2
9	4.8	4.4	0.1
10	4.4	4.5	0
11	4.6	4.6	0.1
12	5.3	4.7	0.2
13	3.3	4.8	0.3
14	2.8	4.8	0.3
15	5.1	4.9	0.4
16	4.2	5.1	0.6
17	4.3	5.3	0.8
18	4.8	5.3	0.8
19	3.6	5.6	1.1
20	5.6	5.6	1.1
Average	4.46	Quarter Avg.	0.6

In Table (2) we can notice the water collected by catch cans and Figure (4) is showing the contour maps by three dimension model for all water applied treatments.

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

Data in Table (2) showing the practical evaluation and collected data of sprinkler systems under study, we can using the data from Table (2) and Equations 1 and 4 as following to calculate % UC and % DU of permanent 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): $UC = 100\ (1-[D/M])$

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

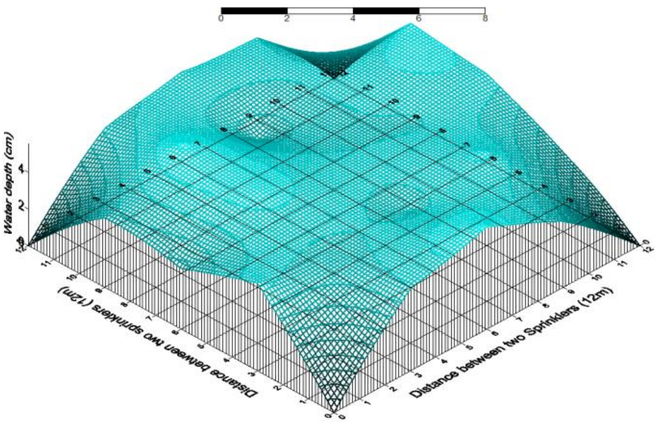

Figure 4: Three dimension model of the water distribution by permanent sprinkler irrigation system.

Table 3: Water requirements for wheat crop at Nubaria sites, Egypt.

Month	Dec	Jan	Feb	March	April	May
ETo (mm/day)	2.8	6.25	5.87	4.15	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	
IRg (mm/month)	36.3	85.2	149.9	184.1	122.1	27.2
IRn (mm/month)	33.0	77.5	136.3	167.4	111.0	24.8

ETo: evapotranspiration , Kc: crop factor, ETc: crop evapotranspiration, IRg: growth water requirements, IRn: net water requirements

DU = Distribution Uniformity (%)

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

Uniformity coefficients (% UC) had been practical evaluated in the experimental field for irrigation system types under studying and resulted were 86.7 % under Permanent sprinkler irrigation systems. Distribution uniformity (% DU) was 78.8 % under Permanent sprinkler irrigation systems. These acceptable results for the sprinkler irrigation systems types under study according to **Kunde, (1985), Solomon, (1983) and Solomon, (1987).** In general, the three dimension model Figure (3) indicated that there are high uniformity distribution by using permanent sprinkler system.

Water requirements

The crop water requirement (CWR), table (3) shows that wheat water requirement is increasing with the passage of time and require maximum amount of water at the crop development and mid-season stage (Table3). Wheat ETc varied from 0.8 through (May) to 5.4 through (March) mm/month. The maximum CWR was observed in the month of March (167.4 mm/month) while the minimum was (24.8 mm/month) observed in the month of May. Values of CWR increases in the month of March (28.4 mm/month) as wheat were in maturity stage. It was also found that crop water requirement was less in the maturity stage as compared to the initial stage. This finding is close to that obtained by **Allen et al, (1998).**

Effect of Evapotranspiration (ETc) levels and wheat varieties on growth, yield and yield components:

Data in Table (4) illustrate the effect of different three water consumptive use levels 100, 75 and 50 % from ETc on a number of spikes/m^2. Regarding field capacities, means values of the number of spikes/m^2, It could be ranked in the following ascending order: 100<75<50. According to a number of spikes/m^2, the effect of field capacities on all studied characters there are significant differences at the 5 % level between all values of characters. Regarding to the number of spikes/m^2, gradually increases were detected by increasing ETc, where application of 50 % from ETc achieved the maximum number of spikes/m^2 (412.50 spikes/m^2). Table (4) Showing that the high number of spikes/m^2 of variety Giza 168 significantly exceeded at 5 % level. According to wheat varieties, means values of the number of spikes/m^2, It could be ranked in the following ascending order: Misr 2 <Misr 1 <Sids 12 < Giza 168, respectively. The results of varieties (Giza 168, Sids 12 and Misr 1) where it gave the highest number of spikes/m^2 relative to Misr 1 Varity.

The interaction between the three reference evapotranspiration levels (ETc) and wheat varieties had a significant effect on the number of spikes/m^2 and the maximum number of spikes/m^2 were obtained by Giza 168 wheat variety applied by 50%ETc. The increasing in the number of spikes/m^2 might be due to the role of ETc levels in stimulating the merited acting and cell elongation of the plant. These results could be attributed to increasing seed yield per ha and the important role of increasing nitrogen and other plant nutrients concentration whenever decreasing water amounts applied.

Data in table (4) Show the effect of the three water consumptive use 100, 75 and 50% from ETc on Seed index (SI) (g) in the 1st and 2nd seasons 2012/2013 and 2013/2014, respectively. Regarding to field capacities, means values of SI, it could arrange in the following ascending order 100<75<50. According to SI, the effect of field capacities and wheat varieties on all studied characters, there are significant differences at the 5 % level between all values of characters. Regarding to SI, increases gradually were detected by increasing ETc, where application of 50 % achieved the maximum SI (50.38 g).

Tables (4) illustrate the SI under variety Giza 168 significantly exceeded at 5 % level. Regarding to wheat varieties means values of SI, it could arrange in the following ascending order: Misr 2 <Misr 1 < Sids 12 < Giza 168. The results of varieties (Sids 12, Misr1 and Misr 2) it gave the highest 1000 kernel weight (g).

The interaction between field capacities and wheat varieties had significant effect on 1000 kernel weight (g) and the maximum number of SI (48.90, 51.85 g) were obtained by Giza 168 wheat variety irrigated by 50% ETc.

Data in Table (4) Illustrated that the effect of three levels from (ETc), (100, 75 and 50 %) on grain yield (GY) (Kg/ha). Regarding to ETc, means values of total GY (Kg/ha), It could arrange in the following ascending order: 100 <75<50. According to GY (Kg/ha), the effect of ETc on all studied characters there is significant differences at the 5 % level between all values of characters. Regarding to GY (Kg/ha), gradually increases were detected by increasing water consumptive use, where application of 50% ETc achieved the maximum GY (Kg/ha) (1865.55Kg/ha).

Table (4) Showing that the higher GY (Kg/ha) variety Giza 168 significantly exceeded at 5 % level. Regarding to wheat varieties, means values of Total GY (Kg/ha), It could arrange in the following ascending order: Misr2 < Misr1< Sids 12 < Giza 168.The results of varieties (Giza 168, Sids 12 and Misr 1) where it gave the highest GY (Kg/ha) relative to Misr 1 variety. Data in Table (4) showed that the effect of three levels from (ETc), (100, 75 and 50 %) on water productivity (WP) (Kg/m^3). Regarding to ETc, means values of total WP (Kg/m^3), It could arrange in the following ascending order: 100 <75<50.

Table 4: Effect of Evapotranspiration (ETc) levels and wheat varieties on growth, yield and yield components.

ETc (%)	Wheat varieties	Number of spikes/m^2	Seed Index (SI) (g)	Grain yield (GY) (Kg/ha)	Water consumptive use (m^3)	Water productivity(WP) (Kg/m^3)
100	Giza 168	404.50	43.30	1650.30	2185.7	0.76
	Sids 12	399.00	40.72	1429.75		0.65
	Misr 1	388.00	37.42	1342.75		0.61
	Misr 2	372.50	32.78	1179.85		0.54
Mean		**391.00**	**38.55**	**1400.75**		**0.64**
75	Giza 168	408.00	46.78	1789.25	1639.3	1.09
	Sids 12	403.00	44.46	1498.40		0.91
	Misr 1	394.00	42.24	1480.80		0.90
	Misr 2	375.50	35.42	1342.75		0.82
Mean		**395.13**	**42.22**	**1527.75**		**0.93**
50	Giza 168	412.50	50.38	1865.55	1092.9	1.71
	Sids 12	407.50	47.24	1615.05		1.48
	Misr 1	401.00	45.83	1591.10		1.46
	Misr 2	381.50	38.83	1379.30		1.26
Mean		**400.63**	**45.58**	**1612.85**		**1.48**
Mean	Giza 168	**408.34**	**46.82**	**1768.45**		**1.18**
	Sids 12	**403.33**	**44.15**	**1514.50**		**1.02**
	Misr 1	**394.34**	**41.83**	**1471.60**		**0.99**
	Misr 2	**376.50**	**35.67**	**1300.85**		**0.87**
$LSD_{0.05}$ for ETc % Means		**3.45**	**2.25**	**92.00**		**0.27**
$LSD_{0.05}$ for Cultivars Means		**2.24**	**0.89**	**32.80**		**0.02**
$LSD_{0.05}$ for Interaction		**4.65**	**1.84**	**52.00**		**0.01**

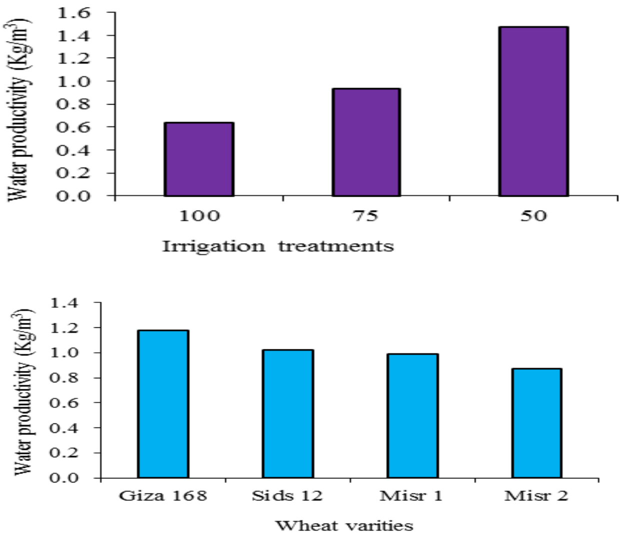

Figure 5: Effect of irrigation treatments and varieties on wheat water productivity.

According to WP (Kg/m^3), the effect of ETc on all studied characters there is significant differences at the 5 % level between all values of characters. Table (4) Showed that the higher WP (Kg/m^3) variety Giza 168 significantly exceeded at 5 % level. Regarding to wheat varieties, means values of WP (Kg/m^3), It could arrange in the following ascending order: Misr2 < Misr1< Sids 12 < Giza 168.The results of varieties (Giza 168, Sids 12 and Misr 1) where it gave the highest WP (Kg/m^3) relative to Misr 1 variety. The interaction between ETc and wheat varieties had a significant effect on GY and the maximum of GY (Kg/ha) were obtained from Giza 168 wheat variety applied with 50 % ETc, and minimum of GY recorded with interaction 100% ETc X Misr 2 Variety. The interaction between ETc and wheat varieties had a significant effect on WP and the maximum WP was (1.71 Kg/m^3)obtained from Giza 168 wheat variety applied with 50 % ETc of water consumptive level, and the minimum of WP was (0.54 Kg/m^3) recorded with interaction 100% ETc X Misr 2 Variety.

Conclusion

Sprinkler irrigation system is one of the important irrigation systems in Egypt, and especially using in sandy soils and it must using with high density crops such as wheat crop it under current field condition. Uniformity coefficients (% UC) Distribution uniformity (% DU) had been practical evaluated in the experimental field for irrigation system types under studying and resulted were 86.7 % and 78.8 %, respectively. In general, the three dimension model indicated that there are high uniformity distribution by using permanent sprinkler system.

Wheat yield and yield components: Spikes no. /m^2, Seed Index, grain yield, and water productivity, under 50 % increased relative to 75and 100 % from ETc levels. On the other hand, under Giza 168, Sids 12, Misr 1 and Misr 2: Spikes no. /m^2, Seed Index, grain yield, and water productivity, varieties increased under Giza 168 relative to Sids 12, Misr 1 and Misr 2 verities. It could be conclude that: treatment of 50 % from ETc applied gave the highest values and it was high in the significant differences between results values, so that for best grain yield and water productivity purpose using applied water 50 and 75 % with a varieties of Giza 168 and Sids 12.

References

[1] **Singh, H.P., Kaushish, S.P., Kumar, A., 2000.** Micro-irrigation. In: Proceedings of the International Conference on Micro and Sprikler Irrigation Systems, 2000, Central Board of Irrigation and Power, New Delhi, February 8–10, p. 794.**Adeoye, K. B. 1986.** Physical changes induced by rainfall in the surface layer of an Alfisol, northern Nigeria. Geoderma.39: 59–66.

[2] **Maas, E.V., Grattan, S.R., (1999).** Crop yields as affected bysalinity. In: Skaggs, R.W., vanShilfgaarde, J. (Eds.),Agricultural Drainage. Agron.Monog.38, ASA, CSSA.SSSA,Madison, Wisconsin, pp. 55–108.

[3] **Levy, Y., Columbus, D., Sadan, D., (1999).** Trickle linear gradientfor assessment of the salt tolerance of citrus rootstocks inthe orchard. Irrig. Sci. 18, 181–184.

[4] **Mishra, B., Shoran, J., Chatrath, R., Chatrath, A.K., Sharma, R.K., Gupta, R.K., Singh,R., Rane, J., Kumar, A., 2005.**Cost Effective and Sustainable Wheat ProductionTechnologies.Directorate of Wheat Research, pp. 36 (Karnal-132001, Technical Bulletin No. 8).

[5] **Ragab, R. A. 1983.** The effect of sprinkler intensity and energy of falling drops on soil surface sealing. Soil Sci. 136(2):117–123.

[6] **Tarchitzky, J., Banin, A., Morin, J. and Chen, Y. 1984.** Nature, formation and effects of soil crusts formed by water dropimpact.Geoderma. 33: 135–155.

[7] **Panini, T., Torri, D., Pellegrini, S., Pagliai, M. and Salvador Sanchis, M. P. 1997.**A theoretical approach to soil porosityand sealing development using simulated rainstorms.Catena. 31: 199–218.

[8] **Sun, Z. Q., Kang, Y. H. and Jiang, S. F. 2008.** Effects of water application intensity, drop size and water applicationamount on the characteristics of topsoil pores under sprinkler irrigation. Agr. Water Manage. 95: 869–876.

[9] **Li, J. and Rao, M. (2000).** Sprinkler water distributions as affected by winter wheat canopy. Irrigation Sci. 20: 29–35.

[10] **Lamm, F. R. and Manges, H. L. (2000).**Partitioning of sprinkler irrigation water by a corn canopy. Trans. Am. Soc. Agr.Eng. 43: 909–918.

[11] **Kang, Y. H., Wang, Q. G. and Liu, H. J. (2005).**Winter wheat canopy interception and its influence factors under sprinkler irrigation.Agr. Water Manage. 74: 189–199.

[12] **Mansour, H. A., (2006).** The response of grape fruits to application of water and fertilizers under different localized irrigation systems. M.Sc: Thesis, Faculty of Agriculture, Agric., Ain Shams University, Egypt.

[13] **Mansour, H. A., (2012).** Design considerations for closed circuits of drip irrigation system. PhD: Thesis, Faculty of Agriculture, Agric., Ain Shams University, Egypt.

[14] **Mansour, H. A., M. Abd El-Hady (2014).** Performance of Irrigation Systems under Water Salinity in Wheat Production. (IOSR-JAVS)-Journal of Agriculture and Veterinary Science 7 (7), 19-24.

[15] **Mansour, H. A., M. S. Gaballah, M. Abd El-Hady and Ebtisam I. Eldardiry (2014)** Influence Of Different Localized Irrigation Systems Andtreated Agricultural Wastewater On Distribution Uniformities, Potato Growth Tuber Yield And Water Use Efficiency. International Journal of Advanced Research, Volume 2, Issue 2, 143 - 150. Journal homepage: http://www.journalijar.com.

[16] **Musick, J.T., Jones, O.R., Stemart, B.A. and Dusek, D.A. 1994.** Water-yield relationships for irrigated and dryland wheat in the US Southern Plains. Agronomy Journal, 86, 980–986.

[17] **Singh, P. K., Mishra, A. K. and Imtiyaz, M. 1991.** Moisture stress and the water use efficiency of mustard. Agricultural Water Management, 20, 245–253.

[18] **Klute, A. (1986).**Water retention: Laboratory methods. In A. Klute (ed.), Methods of Soil Analysi, Part1, Physical and mineralogical methods.635-662, 9 ASA and SSSA, Madison, WI.

[19] **Rebecca, B. 2004.**Soil Survey Laboratory Methods Manual. Soil Syrvey Investigations Report No. 42 Natural Resources Conservation Services.

[20] **Israelsen, O.W. and V.E. Hansen, 1962.** Irrigation Principles and practices. John willey and Sonsins, 3rd Ed., New York.

[21] **Snedecor, G.W. and W.G. Cochran (1980).**Statistical Methods ‖ 7th Edin. Iowa State Univ. Press, Iowa, U.S.A.

[22] **Kunde, R. J. (1985**). Life Cycle Costs Resulting from Various Design Emission Uniformities. Proceedings, 3rd International Drip/Trickle Irrigation Congress, November 18-21, Fresno, CA, Volume II, pp 859-866.

[23] **Solomon, K. H. (1983).** Irrigation Uniformity and Yield Theory.PhD dissertation, Department of Agricultural and Irrigation Engineering, Utah State University, Logan UT, 287 p.

[24] **Solomon, K. H. (1987).** Sprinkler Irrigation Uniformity. Extension Bulletin No. 247, Food & Fertilizer Technology Center, Tapei City, Taiwan, Republic of China.

[25] **Allen R. G., L. S. Pereira, D. Raes and M. Smith, 1998.** Crop evapotranspiration - Guidelines for computing crop water requirements - FAO Irrigation and drainage paper 56. FAO - Food and Agriculture Organization of the United Nations Rome, 1998

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