Egypt. J. Chem. **Vol. 67**, No. 2 pp. 103 - 112 (2024)

Egyptian Journal of Chemistry

http://ejchem.journals.ekb.eg/

Determination of evaporation and transpiration in irrigation water management using the O-18 Stable Isotope technique

Marwa Helmy El-shaer*[1] Mohamed Abdelwahab Kassem[2]
Ahmed Mahrous Hassan[2] Ezzat Abdelmohsen kottb[3]

[1] *Department of Agriculture Enginering Faculty of agriculture Cairo university*
[2] *Cairo University, Faculty of Agriculture, Agricultural Engineering Department*
[3] *Soils and Water Research Department, Nuclear Research Centre, Egyptian Atomic Energy Authority, Abou-Zaabal, 13759, Egypt*

Abstract

One of the primary barriers to economic progress in arid and semi-arid areas is water scarcity. As a result of the water shortage in Egypt, a field experiment was conducted to wheat plants evaluate the effect of drought on wheat at different levels of irrigation which are 100%, 80% and 60% of the water requirements of wheat. A neutron probe was used to estimate the absolute moisture content of the soil. Stable isotopes of oxygen and deuterium were used to Quantify evaporation and transpiration. The results showed that growth parameters decreased by water levels of irrigation according to the following arrangement 100% > 8% > 60% The values were respectively 6986, 6470, 5306.67 and the water use efficiency respectively 1.36, 1.56, 1. 671. Generally, the results indicated that drought was characterized by early maturity, a short grain filling period, a short plant height and the lowest grain yield/plant.

Key words: Evaporation; Drought; Neutron probe; oxygen (18O); Sand soil; Transpiration; water and Wheat

1. Introduction

Wheat (Triticum aestivum L.), one of the most significant staple food crops, it accounts for about 20 % of the human food supply and is cultivated on about 215 million hectares globally **[1]**. Wheat is one of the world's most widely grown crops, accounting for eight percent of global crop production, it has 776 million metric tons being produced in 2020/21 **[2].** Plants often encounter unfavorable conditions, which interrupt their growth and productivity. Among the various abiotic stresses, drought is the major factor that limits crop productivity worldwide **[3]**. However, wheat yield may not be sustained, as crop yields are expected to be negatively affected in the coming years as a result of climate change **[4]**. Drought is one of the most damaging consequences of climate change for crops, and wheat in particular is affected by water stress (WS), mainly during the reproductive phase, which has a negative impact on the production and grain quality, with yield reductions of up to 20% **[5].**

Water scarcity is the most important problem in Egypt. Where the average per capita share of water decreased due to population increase, the average per capita share has reached less than (596.2 m^3 /capita/year) **[6]**. Inadequate water availability during the life cycle of a crop species restricts the expression of its full genetic potential. Most of the crops are sensitive to water deficits, particularly during flowering to seed development stages. Even drought-tolerant crops are adversely affected by water scarcity at reproductive stage **[7]**. There are Three natural stable isotopes of oxygen, ^{16}O, ^{17}O, and ^{18}O. The most abundant is ^{16}O, with a small percentage of ^{18}O and an even smaller percentage of ^{17}O. Oxygen isotope analysis considers only the ratio of ^{18}O to ^{16}O present in a sample. (99.762% natural abundance);

*Corresponding author e-mail: hudaali1192@gmail.com; (Marwa Helmy El-shaer).
Received date 05 June 2023; revised date 15 July 2023; accepted date 31 July 2023
DOI: 10.21608/ejchem.2023.215710.8095

thus oxygen (O) has a relative atomic mass of 15.9994 **[8].**

The relative and absolute abundance of ^{16}O is high because it is a principal product of stellar evolution and because it is a primary isotope, meaning it can be made by stars that were initially made exclusively of hydrogen**[8]**. Stable isotopes of water, ^{18}**O** and ^{2}**H** have been widely used in studies of water movement in the soil-vegetation-atmosphere continuum Evaporation, or the loss of water from soil, results in the fractionation of soil water isotopes. Soil evaporation alters both the soil water content and soil water isotopic composition. In contrast, transpiration, is the loss of water through stomata and cuticle, Wich is not fractionated **[9]**. The factors of evaporation, transpiration, and deep percolation play an important role in agriculture water management. Oxygen-18 was used to determine the three factors in the wheat field under drip irrigation systems: irrigation water, soil water, ground water, and stem water will be sampled for analyses of ^{18}**O** isotope. By the method of soil water balance and Isotope mass balance. Isotopes are atoms of the same element that have the same atomic number, but differ in mass number such as Oxygen - 16, 17 and 18 **[9]**. Evaporation from soil and transpiration from plants both decrease the soil water content, but have different effect on isotopic composition of residual soil water.

Those theories have been used to determine the rate of evaporation and transpiration **[10]**. The oxygen isotopic composition of soil water provides an extra quantitative dimension in water balance analysis that allows separation of evaporation from transpiration. Spatial and temporal variations in water content and oxygen isotopic composition in soils **[11]**.

Neutron probe is used to measure the quantity of water content in soil, neutron probe is containing a pellet of Americium-241-Beryllium. The alpha particles emitted by the decay of these pellets produce very fast-moving neutrons, which collide with the hydrogen nuclei present in the soil being used for measurements and lose their energy. During this process, the neutron velocity decreases by several thousand times and then returns back to the probe. It measures the amount of hydrogen present in the soil and hence is used for soil moisture measurements **[12].**

2. Materials and Methods

2.1. The experimental layout

The field experiment was conducted in sandy soil at the farm of Soil and Water Research Department, Nuclear Research Center, Atomic Energy Authority, Inshas, Sharkia Egypt. The latitude and longitude of the experiment site 30^0 24 N, 31^0 35 E, while the altitude is 20m above the sea level. Drip irrigation system was installed to irrigate an area $182.25m^2$ consists of: - One hp solar pumping system. A 75mm diameter PVC main line, and manifold of a PVC 50mm pipe in diameter. - Lateral lines were tubes of 16 mm diameter PE, 30cm built in emitter distance, 4 l/hr. Water gauges and manometer. Seeds of wheat (Triticum aestivum l.) variety Giza 168 obtained from Agriculture Research center, Cairo, Egypt was cultivated. Mechanical, Chemical and irrigation water analysis for determine the type of soil to identify physical and Chemical properties of the soil and water under study, shown in tables (1,2 and 3) respectively.

The total area of experiment was $182.25m^2$, which was divided into three treatments. Each treatment had three replications of cultivated wheat (Triticum aestivum); Giza 168 variety. The experiment was started on 22nd November, 2020 and was harvested on 11th April 2021.

Experimental design was complete randomized block design (CRBD) of three treatments with three replicates were used. Experimental plot area was 4.5m*4.5m.

Table (1) Some physical characteristics of the experimental soil

Soil Depth (cm)	Particle size Distribution (%)			Soil texture	Bulk Density (g /cm^3)	Total Porosity (%)	Hydraulic Conductivity cm.h^{-1}	Moisture content by Volume (%)		
	Clay	Silt	Sand					FC	WP	AW
0-15	1.40	2.5	96.1	Sand	1.78	32	21.36	12.5	1.66	10.92
15-30	0.60	1.80	97.6	Sand	1.77	33	20.70	11.4	1.92	10.2
30-45	0.50	1.30	98.2	Sand	1.76	33	22.33	8.78	1.31	7.42
45-60	0.40	1.00	98.6	Sand	1.75	33	23.15	8.77	1.32	7.52
60-75	0.50	0.90	98.4	Sand	1.73	34	22.85	8.66	1.3	7.45
75-90	0.90	0.90	98.2	Sand	1.73	34	26.77	9.82	1.36	8.55

Table (2) Some chemical characteristics of the experimental soil

Soil Depth (cm)	Soluble Cations (meq l^{-1})				Soluble Anions (meq l^{-1})				Ec (dSm^{-1})	pH (1:2.5)
	Ca^{++}	Mg++	Na +	K+	CI-	HCO_3^-	SO_4^-	CO_3^-		
0-15	2.55	3.04	3.69	1.04	3.27	3.30	3.96	--	1.38	8.57
15-30	1.12	1.48	1.14	0.48	1.07	2.80	0.40	--	0.44	9.20
30-45	0.74	1.72	1.01	0.42	0.93	2.40	0.58	--	0.43	9.40
45-60	0.89	1.60	0.63	0.28	0.73	2.40	0.34	--	0.36	9.52
60-75	0.99	1.52	0.58	0.23	0.80	2.30	0.31	--	0.37	9.62
75-90	0.72	1.56	0.57	0.24	0.80	2.20	0.17	--	0.34	9.41

Table (3) Some characteristics of the experimental Water

Parameter	Value	Parameter	value
pH	7.41	**Magnesium as Caco3**	20mg/l
EC	500mS/cm	**Sodium (Na)**	12mg/l
Turbidity	12NTU	**Iron (Fe)**	0.2mg/l
Hardness, Total	170mg/l	**Copper (Cu)**	0.03 mg/l
Fluoride	0.3mg/l	**Potassium (K)**	5mg/l
Calcium as CaCo3	70mg/l	**Carbonate (Co3)**	2.5 mg/l
Chloride (Cl)	35 mg/l	**Bicarbonate (Hco3)**	135 mg/l
Sulphate (So4)	50 mg/l	**Silica (SiO2 Non-reactive**	3 mg/l

2.2. Neutron calibration of neutron moisture meter

Figure (1): Neutron calibration curves for different soil depths, at 30, 45, 60 and 75cm. Soil moisture was determined at a depth of 15 cm below the surface of the soil using neutron probe Gauge model 4302, Source AM-241:BE, ACT 10 mci (0.37GBq) In the field. the neutron probe was calibrated by correlating the neutron probe count ratio with volumetric water content measured using the gravimetric method and bulk density, a 100 cm neutron tube was put up near the middle of each plot and 30, 45, 60, and 75 cm away from lateral, IAEA [13].

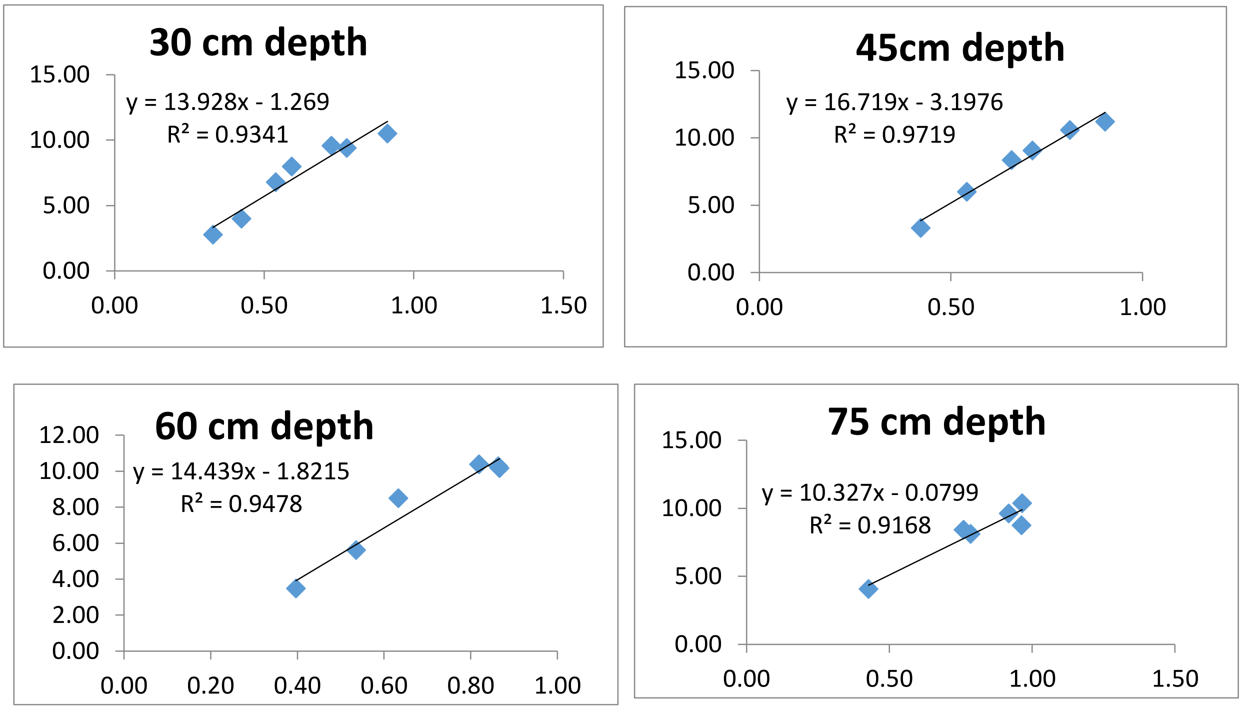


Figure (1): Neutron calibration curves for different soil depths at 30, 45, 60 and 75cm.

2.3. Measurements and sampling

In this study, the dynamics of soil water were tracked, and samples of irrigation water, soil water and stem water were taken measurement of oxygen stable isotopes. Although the layers from (15 - 30, 30 - 45 , 45 - 60, 60 - 75) were measured using a neutron moisture meter. The surface depth of 0 to 15 cm was used to test the soil's water content using the gravimetric technique. A nearby on-site weather station was used to track meteorological parameters, such as precipitation, temperature, moisture, wind speed and direction, net solar radiation, and reference Evapotranspiration.

2.4. *Stable isotope and data analysis*

The values of O^{18}/O^{16} ratio for soil water and plant stem water compared to the ratio of 18O /16O in irrigation water. To analyze oxygen and Hydrogen - stable isotopes irrigation water, soil water, and stem water were all examined. Four times during the growing season, were taken from the experiment under Study. Data were gathered at midday. Four irrigation events—9/12/2020, 27/1/2021, 24/2/2021, and 17/3/2021—were selected during growth stages.

Stem samples were taken at the lowest part of the plant near the soil surface. Soil samples were taken from each replicate, near the plant roots the large roots were excluded, samples were taken from the depth (0-7.5 cm, 7.5-15cm, 15-25cm).

Soil and plant water was extracted in the lab **[14]**. by using cryogenic vacuum distillation in Soil and Water Research Department, Nuclear Research Center, Atomic Energy Project Raf 5057. The samples were placed in 2ml vials and there were made two replicates from each. The water samples were isotopically analyzed at (IAEA) Laboratory using a spectrometer laser DLT-100 (± 1 standard deviation). to isotopically analyses the water samples. For repeated analyses of laboratory standards, O^{18} and D's respective standard deviations were 0.2 and 1‰. These isotope concentrations are represented using the notation in per mil (‰) and as a deviation from a global standard (V-SMOW): Equation 2

δ ‰=[(Rs/Rst)-1] *1000 (Eq 1)

Where Rs and Rst are the molar ratio of the heavy to light isotopes in the sample and the standard, respectively.

Stable Oxygen: R= ($^{18}O/^{16}O$) = (2005.2±0.45) $\cdot 10^{-6}$

Stable Hydrogen: R= ($^{2}H/^{1}H$) = (155.76±0.05) $\cdot 10^{-6}$

3. Results and Discussions

3.1. Amount of Irrigation Applied.

Irrigation water was applied based on the recommended crop water requirement according to FAO irrigation and Drainage paper 33 [**15].** Evapotranspiration for wheat was calculated from meteorological station located at the site according to Penman–Monteith equation[**16**]. Data in Table (4) show the amount of applied water irrigation for wheat crop for the complete growing season, at 100%, 80% and 60% of Irrigation water Levels.

Table (4) amount of applied water irrigation at 100%, 80% and 60% of Irrigation water Levels

Stage	Duration	mm/Stage	m^3ha^{-1}
Intial growth stageof all levels of irrigation water	21	26.2657	262.657
100%			
Development	49	117.09	1170.93
Mid-Season	49	272.08	2720.80
Late-Season	21	97.66	976.61
Total	140	513.1	5130.99
80%			
Development	49	93.67	936.74
Mid-Season	49	217.67	2176.64
Late-Season	21	78.13	781.29
Total	140	410.48	4157.33
60%			
Development	49	70.26	702.56
Mid-Season	49	163.25	1632.48
Late-Season	21	58.6	585.97
Total	140	307.86	3183.66

3.2. Soil moisture contents measurements

Soil moisture contents were measured in the surface depth of 0-15 cm using gravimetric method to prevent neutron escaping through the air, while the layers from (15-30, 30-45, 45-60, 60-75) were measured by a neutron moisture meter.

Table (5) The measurement of soil moisture content in intial growth stage of cultivation before and after 2hr.of irrigation

Depth	100% WR			80 % WR			60 % WR		
	BI	AI	D	BI	AI	D	BI	AI	D
15	3.5	6.1	2.6	3.4	6.03	2.63	3.45	5.94	2.49
30	3.52	4.9	1.38	3.5	4.89	1.39	3.38	4.88	1. 5
45	3.88	4.31	0.43	3.8	4.21	0.41	3.69	4.09	0.40
60	4.1	4.36	0.26	4.03	4.29	0.26	3.93	4.2	0.27
75	3.95	4.32	0.37	3.93	4.27	0.34	3.88	4.23	0.35

Table (6) The measurement of soil moisture content in development stage of cultivation before and after 2hr.of irrigation

Depth (cm)	100% WR			80 % WR			60 % WR		
	BI	AI	D	BI	AI	D	BI	AI	D
15	3.5	7.45	3.95	3.45	6.64	3.19	3.45	5.98	2.53
30	3.65	5.69	2.04	3.49	5.33	1.84	3.34	4.88	1.54
45	3.8	4.78	0.98	3.69	4.45	0.76	3.63	4.22	0.59
60	3.65	4.27	0.62	3.52	4.02	0.50	3.52	3.95	0.43
75	3.47	4.1	0.63	3.52	4.04	0.52	3.4	3.85	0.45

Table (7) The measurement of soil moisture content in mid-season stage of cultivation before and after ^{2}hr. of irrigation

Depth (cm)	100% WR			80 % WR			60 % WR		
	BI	AI	D	BI	AI	D	BI	AI	D
15	3.6	7.96	4.36	3.55	7.04	3.49	3.5	6.12	2.62
30	3.61	5.98	2.37	3.54	5.44	1.9	3.49	5.05	1.56
45	3.82	4.88	1.06	3.8	4.65	0.85	3.74	4.36	0.62
60	3.67	4.35	0.68	3.67	4.21	0.54	3.6	4.01	0.41
75	3.52	4.24	0.72	3.57	4.12	0.55	3.5	3.93	0..43

Table (8) The measurement of soil moisture content after in Late-season stage of cultivation before and after ^{2}hr.of irrigation

Depth (cm)	100% WR			80 % WR			60 % WR		
	BI	AI	D	BI	AI	D	BI	AI	D
15	0.35	7.3	3.8	3.45	6.43	2.98	3.35	5.63	2.28
30	3.54	5.57	2.03	3.4	5.02	1.62	3.35	4.52	1.17
45	3.71	4.73	1.02	3.69	4.5	0.81	3.63	4.23	0.60
60	3.55	4.16	0.61	3.5	3.99	0.49	3.45	3.82	0.37
75	3.45	4.12	0.67	3.4	3.94	0.54	3.36	3.76	0.40

BI = Before irrigation, AI = After irrigation, D = Difference between Before and After Irrigation

Under field conditions, drought stress declined total chlorophyll according to arrangement 100% > 80 % > 60% respectively.

To mitigate the impact of water stress, plants use different strategies such as morphological, anatomical and physiological mechanisms to reduce transpiration, improve water absorption and limit oxidative damage. Chlorophyll concentration has been known as an index for evaluation of source **[17]** therefore, a decrease of this can be considered as a non-stomata limiting factor in the drought stress conditions. There are reports about the decrease of chlorophyll in drought stress conditions **[18].**

In the present study wheat plants were tested under 100%, 80% and 60% of irrigation water showed significant respectively decrease in growth parameters (leaf area, leaf length, leaf weight, root length, root weight, spike length/Plant, total length/plant, number of spike /plant, number of grains/ spike, 100 grain weight and grain Yield/ha). Maximum growth parameters were recorded at 100% followed by 80% then 60% as recorded in table 5. Thus, Plants dry matter production was adversely affected by drought. Analysis of variance showed significant and highly significant effects for irrigation treatments on grain yield as shown in table 5 the grain yield significantly decreased from 6.99 to 6.47 to 5.31 tons/ha at 100%, 80% and 60% of irrigation respectively. These results could be attributed predominantly with decreasing in spikes per unit area and rains per spike which was also attributed to reduction in the number of effective tillers.

Table (9) Means of agronomical and phycological traits of wheat as influenced by Irrigation Levels

Irrigation Levels	Leaf Area Cm^2	Total Chlorophyll	Leaf Length	Leaf Weight	Root Length	Root Weight
100%	39.5	48.4	28.3	0.24	14	3.16
80%	37.23	47.87	27.5	0.23	14	3.03
60%	29.91	46.77	25	0.20	12.33	2.48
	No of spike/Plant	**No of grains/ spike**	**spike length/Plant**	**Total length/Plant**	**100 Grain weight**	**Grain Yield/ha**
100%	4.33	42	13.4	103.67	5.97	6986.67
80%	3.66	40.67	12.27	102.5	5.93	6470
60%	2.33	36.67	10.23	95.5	4.77	5306.67

Each value is the mean three replicates

3.3. Wheat crop production

Figure (2) shows how varying irrigation water levels affect the yield of wheat plants grown using a trickle irrigation system. The overall yield ranged from 7 to 5.31 tons per hectare. The greatest yield was obtained with a treatment of 100%. The lowest one was obtained with a treatment of 60%, while the highest one was acquired when employing 100%, which virtually equals non-stressed situations. The yield was reached in the following order: 100% > 80% > 60%.

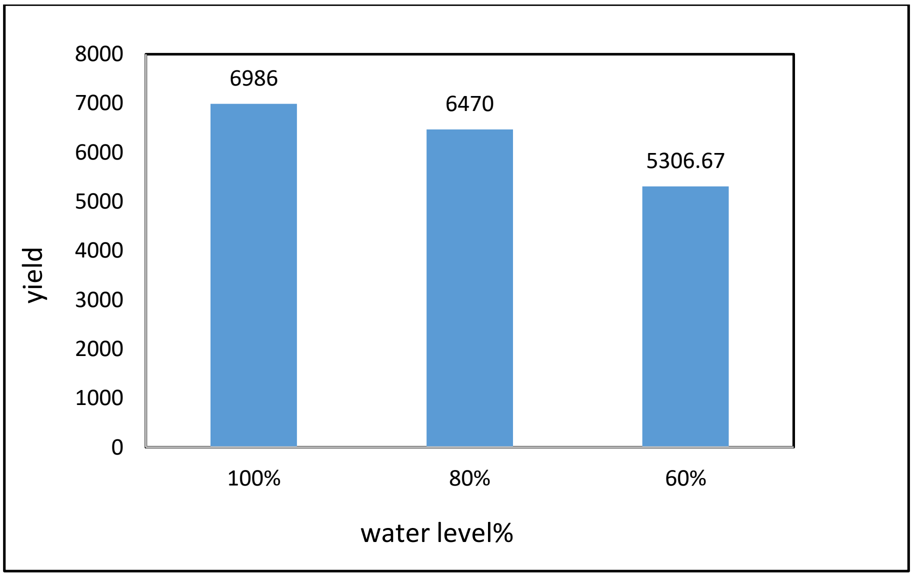


Figure (2): Water productivity (WP) related to different Water Irrigation Levels

The data in Figure (3) illustrates how the irrigation water level affects the Water productivity (WP) of wheat crop the obtained results show that the (WUE) somewhat decreases when irrigation water level increases from 100% up to 60%. The greatest WUE value which was obtained by 60% and the lowest value is 100%. The WUE value were 1.67, 1.56 and 1.36 kg m3 for 60%, 80% and 60% respectively.

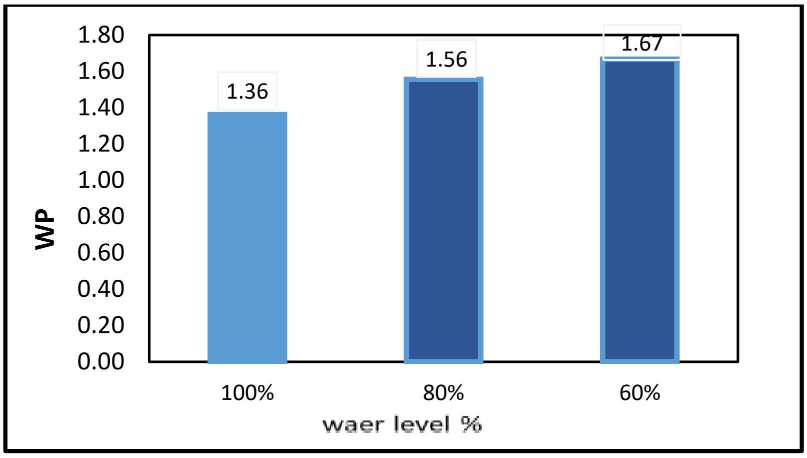


Figure (3): Water use efficiency (WUE) related to different Water Irrigation Levels

3.4. ^{18}O and $^{\delta}D$ Isotopes:

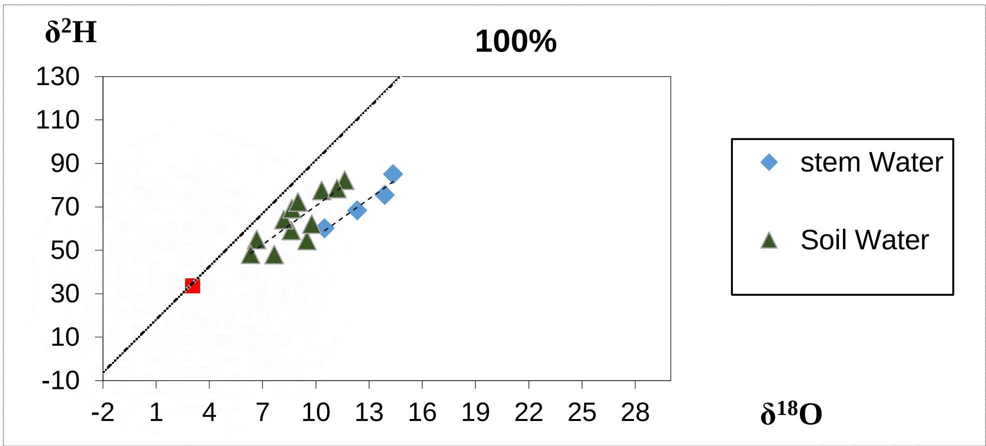
Figure (5,6 and 7): Illustrate the value of stable isotopic composition of Irrigation water, stem water and soil water.

At 100% of irrigation water Isotopic compositions of irrigation water (δIW) were 3.09 % for $\delta\ ^{18}O$, and 33.5 % for $\delta\ ^{2}H$ (δD). Isotopic compositions of soil water (δSW) ranged from 6.32 % to 11.63 % for $\delta\ ^{18}O$, and from 48.15% to 82.33% for $\delta\ ^{2}H$. Isotopic ratios of stem water (δStW) ranged from 10.49 % to 14.35% for $\delta\ ^{18}O$, and from -54.39 % to 78.19 % for $\delta\ ^{2}H$.

At 80% of irrigation water Isotopic compositions of irrigation water (δIW) were 3.09 % for $\delta\ ^{18}O$, and 33.5 % for $\delta\ ^{2}H$ (δD). Isotopic compositions of soil water (δSW) ranged from 6.29 % to 11.44 % for $\delta\ ^{18}O$, and from 40.32 to 82.33 for $\delta\ ^{2}H$. Isotopic ratios of stem water (δStW) ranged from 10.44 % to 14.02% for $\delta\ ^{18}O$, and from -58.22 % to 79.4 % for $\delta\ ^{2}H$.

At 60% of irrigation water Isotopic compositions of irrigation water (δIW) were 3.09 % for $\delta\ ^{18}O$, and 33.5 % for $\delta\ ^{2}H$ (δD). Isotopic compositions of soil water (δSW) ranged from 5.99 % to 11.04 % for $\delta\ ^{18}O$, and from 35.2 % to 79.44 % for $\delta\ ^{2}H$. Isotopic ratios of stem water (δStW) ranged from 10.33 % to 13.92 % for $\delta\ ^{18}O$, and from -54.39 % to 78.19 % for $\delta\ ^{2}H$.

These results indicated that isotopic values of evaporation water from soil surface (δE, soil evaporation) were more isotopically depleted relative to water evaporated by plant transpiration (δT). All samples (soil water, stem water, irrigation water) are situated around the local Meteoric Water Line (LMWL). The regression line of all samples intersects the LMWL at the point that presents the origin of all samples.



GMWL = Global Meteoric Water Line

Figure (4): $\delta\ ^{18}O$ versus $^{\delta}D$ in plants, irrigation water, stem water and soil water in 100% irrigation water level

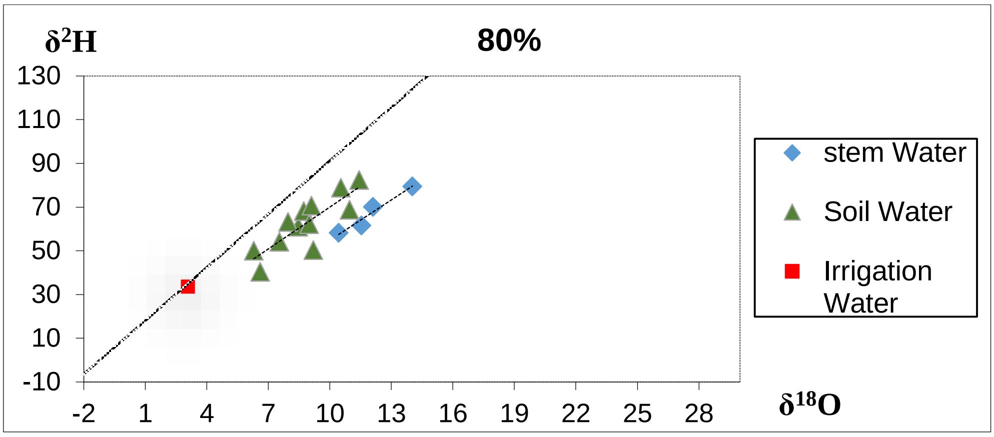


Figure (5): δ [18]O versus [δ]D in plants, irrigation water, stem water and soil water in 80% irrigation water level.

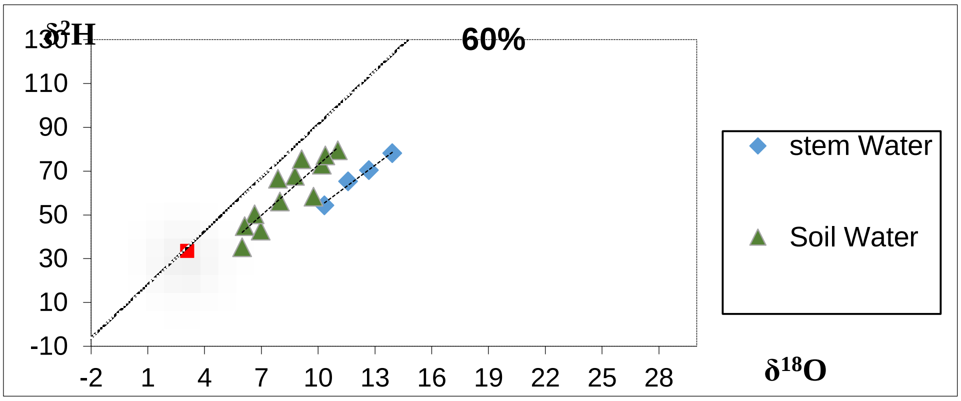


Figure (6): δ [18]O versus [δ]D in plants, irrigation water, stem water and soil water in 60% irrigation water level.

4. Conclusions

The results indicated that the highest yield production at 100% irrigation water more than 80% while 60% was the lowest in yield production of wheat. As well as the results indicated that isotopic values of evaporation water from soil surface (δE, soil evaporation) were more isotopically depleted relative to water evaporated by plant transpiration (δT). All samples (soil water, stem water, irrigation water) are situated around the local Meteoric Water Line (LMWL). The regression line of all samples intersects the LMWL at the point that presents the origin of all samples. The stable isotopes content and Keeling plots allowed the partition of ET into different flux components for wheat. results confirm the efficiency of the irrigation system applied in experiment by considering just the evaporation loss.

5. References

[1] WHEAT (2014) Wheat: vital grain of civilization and food security 2013 Annual Report, CGIAR Research Program on Wheat, Mexico.

[2] FAO STAT. Food and Agricultural Organization of United Nation, Roma. Available online: http://www.fao.org/faostat/ (accessed on 31 January 2022).

[3] Tardieu, F., Parent, B., Caldeira, C.F., Welcker, C. 2014. Genetic and physiological controls of growth under water deficit. Plant Physiol. DOI:10.1104/pp.113.233353

[4] Bento, V.A.; Ribeiro, A.F.S.; Russo, A.; Gouveia, C.M.; Cardoso, R.M.; Soares, P.M.M. The impact of climate change in wheat and barley yields in the Iberian Peninsula. Sci. Rep. 2021, 11, 15484. [CrossRef] [PubMed].

[5] Daryanto, S.; Wang, L.; Jacinthe, P.A. Global synthesis of drought effects on maize and wheat production. PLoS ONE 2016, 11, e0156362. [CrossRef] [PubMed] .

[6] Allam, M. N., & Allam, G. I. 2007. Water Resources in Egypt: Future Challenges and Opportunities. Water International, 32(2), 205-218. http://dx.doi.org/10.1080/02508060708692201

[7] **Mitra, J. 2001.** Genetics and genetic improvement of drought resistance in crop plants. Curr. Sci. 80: 758-763.

[8] **Audi G.; A. H. Wapstra; C. Thibault; J. Blachot; O. Bersillon 2003.** "The NUBASE evaluation of nuclear and decay properties" (PDF). Nuclear Physics A. **729**: 3–128. Bibcode:2003 NuPhA. 729..3A. doi:10.1016/j.nuclphysa.2003.11.001.

[9] **Peng Wanga,b, Xianfang Songb, Dongmei Hanb, Yinhua Zhangb, Bing Zhangb**. (2012). Determination of evaporation, transpiration and deep percolation of summer corn and winter wheat after irrigation. Agriculture water anagement, 105, 32-37

[10] **Wenninger**, J., Beza, D.T., Uhlenbrook, S., 2010. Experimental investigations of water fluxes within the soil-vegetation-atmosphere system: stable isotope massbalance approach to partition evaporation and transpiration. Phys. Chem. Earth A/B/C 35, 565–570

[11] **Jean C.C. Hsieh,Oliver A. Chadwick, Eugene F. Kelly, Samuel M. Savin**. (1997). Oxygen isotopic composition of soil water Quantifying evaporation and transpiration. DiÍision of Geological and Planetary Sciences, California Institute of Technology, Pasadena,CA 91125, USA.

[12] **Herzog H (1986)** Source and sink during reproductive period of wheat. Scientific publishers. Berlin and Hamburg. 147- 148.

[13] **IAEA,2003,** Neutron and gamma probe: Their use in agronomy. Training course series 16.Vienna.

[14] **Ehleringer JR, Roden J, Dawson TE (2000).** Assessing ecosystem-level water relations through stable isotope ratio analysis. In O.E. Sala, R.B. Jackson, H.A. Mooney and R.W. Howarth (eds.), Methods Ecosyst. Sci. Springer, New York pp. 181-198.

[15] **Doorenbos, J., Kassam, A.H., 1979.** Yield response to water. FAO Irrigation and drainage paper 33, FAO, Rome, Italy.

[16] **FAO (1998).** Crop evapotranspiration-Guidelines for computing crop water requirements, Irrigation and drainage paper, FAO, Rome, Italy.

[17] **Kuroda M T, Imagawa H (1990)** Changes in chloroplast peroxidise activities in relation to chlorophyll loss in barley leaf segments. Physiol Planta 80:555-560.

[18] **Majumdar S, Ghosh S, Glick BR, Dumbroff EB (1991)** Activities of chlorophyllase, phosphoenolpyruvate carboxyllase and ribulose-1,5-bisphosphate carboxylase in the primary leaves of soybean drying senescence and drought. Physiol Planta 81:473-480

18" -" تقدير التبخر والنتح في إدارة مياه الري باستخدام تقنية النظير المستقر الأكسجين

مروي الشاعر [1] ، محمد عبد الوهاب قاسم[2]، أحمد محروس حسن[2]، عزت المحسن قطب[1]

[1]قسم بحوث الاراضي والمياه –مركز البحوث النوويه- هيئة الطاقة الذرية المصرية ، 11787 ، القاهرة ، مصر
[2]قسم الهندسة الزراعية جامعة القاهرة

المؤلف المسئول: عزت عبد المحسن قطب
تليفون: 01090906712
البريد الاليكتروني: ezzatkotb2000@yahoo.com

الملخص

أجريت التجارب الحقلية بالمزرعة البحثية الخاصة بقسم بحوث الأراضي والمياه، مركز البحوث النووية، هيئة الطاقة الذرية، أنشاص تقع التجربة علي خط عرض24 ^{0}30 شمالاوخط طول 35 ^{0}31 شرقا وأرتفاع 20 متر فوق سطح البحر. وأجريت التجارب المعمليه بوحدة هندسة الطاقات المتجددة والمياه بالمركز وأجريت القياسات لتقدير نسبة الأكسجين-18 بهيئة الطاقة الذرية بالمغرب. وذلك لدراسة تأثير إضافة مستويات مختلفة من مياه الري وهي 60%، 80%، 100% من البخر نتح علي محصول القمح المنزرع في تربة رملية تحت نظام الري بالتنقيط وتم عمل تحليل ميكانيكي وكيميائي لتحديد الخواص الفيزيائية والكيميائية للتربة كما تم عمل تحليل كيميائي لماء الري المستخدم في الزراعة. تم إستخدام تصميم القطاعات كاملة العشوائية مع ثلاث مكررات تحت ثلاث معاملات.تم تقدير البخر نتح المرجعي بواسطة وحدة الأرصاد بالهيئة التي تستخدم معادلة بنمان مونتيث لحساب البخر نتح المرجعي.مع تقدير البخر من سطح التربة والنتح للنبات بإستخدام تقنية الأكسجين-18 وذلك بفصل النتح بخر إلي البخر من سطح التربة والنتح من أوراق النبات. تم تقدير المحتوي الرطوبي للتربة بطريقة الجرافيمتريك من عمق 0-15 ومن عمق 15-25سم ،25-50 سم ،50- 75 سم بواسطة جهاز النيترون بروب تم أخذ عينات من كل من ساق النبات و التربة علي أعماق من صفر-7.5سم، 7.5- 15سم، 15- 25سم، 25-50 سم. و تم إستخلاص الماء الموجود في طبقات سطح التربة والماء الموجود في ساق النبات أربعة مرات خلال مراحل النمو. تم إرسال العينات للقياس بجهاز التحليل الطيفي بالليزر للنظائر في الماء لتقدير الأكسجين-18 في مياه الري وتقدير الأكسجين-18 في المياه الجذعيه للنبات وتقدير الأكسجين-18 في طبقات التربة وذلك بهدف زيادة كفاءة إستخدام المياه عن طريق التقليل من الماء المفقود بالبخر من سطح التربة والإستفادة من ماء النتح من سطح النبات.